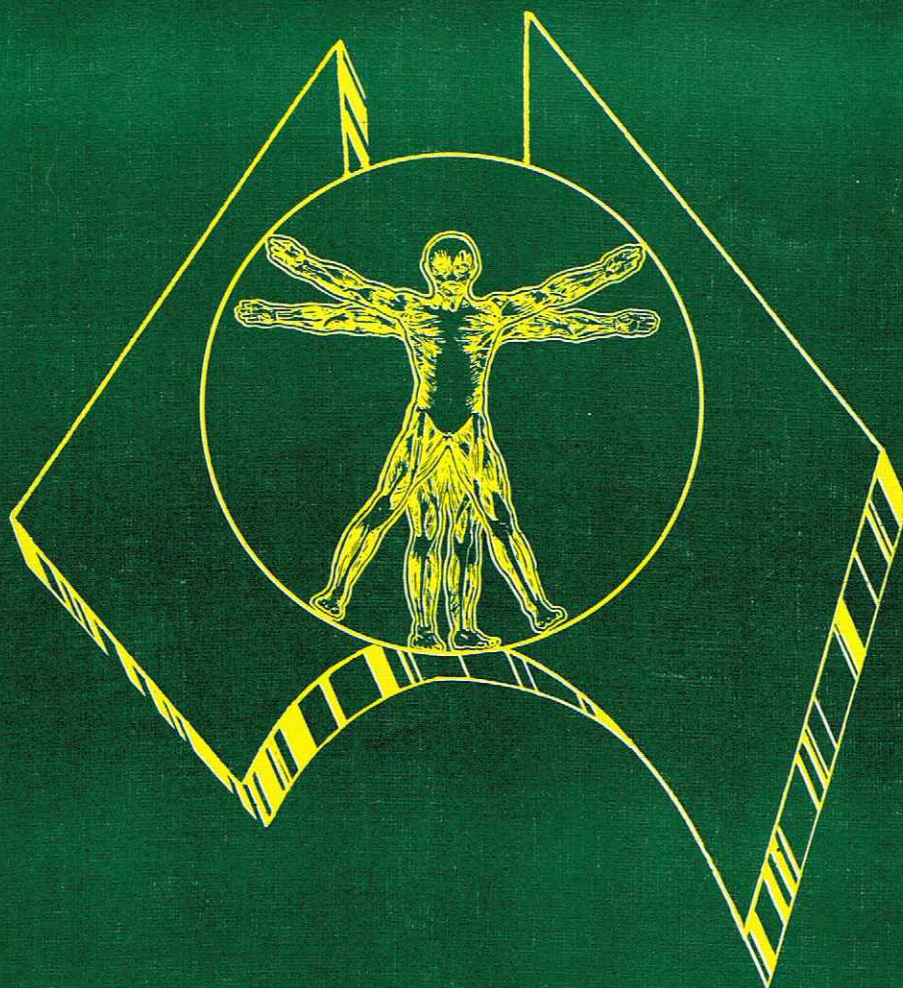


**Australian
Association of
Musculoskeletal
Medicine**

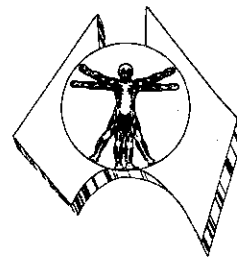
Bulletin



Disc Degeneration

Vol. 4 No. 3 September 1988
Registered by Australia Post Publication No. NAW 6362

Australian Association of Musculoskeletal Medicine



Bulletin

Vol.4 No.3

September 1988

CONTENTS

Office-bearers 1988	3
Editorial	4
From the Hon. Secretary's Desk	6
Coo-ee	6
1987 Annual Scientific Meeting Report	7
A.A.M.M. News	8
Meetings, Conferences and Courses	10
1988 Annual Scientific Meeting	12
1988 Winter Meeting Report	14
F.I.M.M. News	15
Mailbag	16
Structural and Mechanical Disc Changes with Age <i>L. Twomey and J. Taylor</i>	18
The Role of Mechanical and Genetic Factors in Degeneration of the Disc <i>Peter Ghosh</i>	22
The Forces Acting on a Lumbar Intervertebral Joint <i>W.C. Hutton</i>	27
A.A.M.M. Abstracts	29
Book Review	58
Statistical Validation of Manipulative Therapy for the Treatment of Severe Muscle Wasting	60

The A.A.M.M. Bulletin is published by the Australian Association of Musculoskeletal Medicine for medical practitioners interested in the aetiology and management of musculoskeletal disorders. Opinions expressed are those of the authors and not necessarily those of the editor or the Association. Editorial comment may reflect the opinions of the editor alone. Contributions on any relevant topic are welcome for submission to the editor, Dr. Wade King, P.O. Box 1044, Taree, NSW, 2430, telephone (065) 50 5167, or to any member of the A.A.M.M. Committee.
Printed by A.M. Printing Services, 127 Bridge Street, Tamworth, NSW, 2340, telephone (067) 65 4199.
Typeset by Belaser Type Services, PO Box 1083, Tamworth, NSW, 2340, telephone (067) 67 8315.

THE ORIGINAL McKENZIE LUMBAR AND CERVICAL ROLLS

The **only** rolls inspected and approved by Robin McKenzie for use with his treatments.

The McKenzie Lumbar Roll

Manufactured and Distributed
Exclusively in Australia by —

D.E.S.M.A.

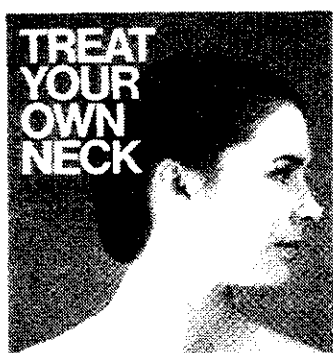
P.O. Box 85, INVERELL, 2360
Phone: (067) 22 3602; 22 2583 A.H.



Modern mechanical therapy for spinal pain . . .

BOOKS AVAILABLE THAT WILL ASSIST YOUR PATIENTS TO ACHIEVE INDEPENDENCE THROUGH SELF CARE.

Practical texts to aid back and neck pain sufferers. The well illustrated step by step remedial exercises complement professional therapy and provide ideal prophylaxis advice for your patients. Written by Robin McKenzie, FNZSP, MNZMTA, a member of the *International Society for the Study of the Lumbar Spine* and an acknowledged authority in this field.



TREAT YOUR OWN BACK

REVISED 3RD EDITION

Single copy	\$10.00 ea.
2-24 copies	\$7.90 ea.
25-49 copies	\$7.40 ea.
50 copies	\$6.90 ea.

TREAT YOUR OWN NECK

Single copy	\$10.00 ea.
2-29 copies	\$7.00 ea.
30-59 copies	\$6.50 ea.
60 copies	\$5.50 ea.



Also available, the professional text:

"THE LUMBAR SPINE: MECHANICAL DIAGNOSIS AND THERAPY"

at \$45.00 per copy.

All titles readily available from

SPINAL PUBLICATIONS (AUSTRALIA)

Telephone: 067-223602

15 OLIVER STREET, INVERELL, NSW 2360

(P.O. Box 85)

AUSTRALIAN ASSOCIATION OF MUSCULOSKELETAL MEDICINE

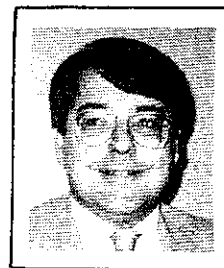
OFFICE-BEARERS 1988

The following members were elected to office at the annual general meeting in Brisbane on 23rd October, 1987.

PRESIDENT:

Dr. Nikolai Bogduk BSc (Med) (Hons), MB, BS (Hons), PhD,
Dip Anat, Hon MMTAA.

Faculty of Medicine, University of Newcastle
Newcastle, NSW., 2308
telephone (049) 68 5699



HON. SECRETARY:

Dr. David Vivian MB, BS

441 Bay Street, Brighton, Vic., 3186
telephone (03) 596 7211



HON. TREASURER:

Dr. Wade King MB, BS

P.O. Box 1044, Taree, NSW, 2430
telephone (065) 50 5167



COMMITTEE MEMBERS:

Dr. Norm Broadhurst	Adelaide, S.A.	(08) 295 1890
Dr. Alex Ganora	Thirroul, NSW	(042) 67 2811
Dr. Clive Kenna	Melbourne, Vic.	(03) 568 8166
Dr. Carl Rotkirch	Brisbane, Qld.	(07) 344 1022
Dr. John Varejka	Grenfell, NSW	(063) 43 1211
Dr. Vern Vivian	Point Lonsdale, Vic.	(052) 52 2009
Dr. Roger Watson	Townsville, Qld.	(077) 71 3084

STATE REPRESENTATIVES:

ACT:	Dr. Goff Nelson	(062) 95 6773
NSW:	Dr. Barry Abeshouse Dr. Howard Rivett	(02) 428 5065 (02) 439 3335
QLD:	Dr. Roger Watson Dr. Ron Palmer	(077) 71 3084 (07) 269 1842
SA:	Dr. Norm Broadhurst Dr. Dick Hodgson	(08) 295 1890 (08) 277 7879
TAS:	Dr. Ron Heddle Dr. Tim Begbie	(002) 34 5990 (002) 64 1488
VIC:	Dr. Murray Deerbon Dr. David Vivian	(03) 729 4011 (03) 596 7211
WA:	Dr. Marius Loeffler	(097) 33 5220

Editorial

The annual conference, to be held in early December, will mark the end of the eighteenth year of the A.A.M.M.'s activities and the beginning of the nineteenth. It is a time for reviewing what has been accomplished and for re-appraising the Association's immediate goals and their means of attainment.

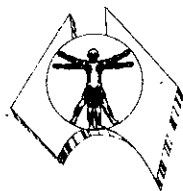
The achievements of the last few years have been considerable. In that time the Association has produced a great deal of tangible evidence of its standing in both clinical and educational spheres. Reinforced by these credentials, it has seen fit to take a very active role in the promotion of musculoskeletal medicine as a distinct discipline of medical science.

The Association's views on this and related matters have been clearly stated to, and acknowledged by, a number of governmental and professional bodies including the Commission of Inquiry into Medical Education and the Medical Workforce, the N.S.W. Medical Board and the N.S.W. Branch of the A.M.A. The submissions to these bodies have been based on the key point of the perceived needs of a great many patients who suffer chronic pain and disability with musculoskeletal problems which are inadequately understood and, consequently, poorly managed.

The Association's attitude, clearly stated in its various submissions, is that the only rational approach to problems of pain and disability is by employing the medical, rather than the political, sociological, financial or any other ideological, model. In essence, there is no special mystery about the musculoskeletal system other than that due to inadequate understanding. The strategies used for the assessment and management of problems related to the cardiovascular or respiratory systems are just as valid when applied to musculoskeletal mechanisms. The patient needs (and at the very least, deserves) a rational and sympathetic assessment by way of detailed history-taking, comprehensive physical examination and the application of appropriate ancillary investigations. Only when the results of such a combination of procedures are related to objective criteria can a reasonable assessment be claimed to have been made and only when a patient's condition has been properly assessed can any logical management plan be formulated.

There are many roles to be fulfilled in the various processes involved and on no account does the A.A.M.M. claim a monopoly for the practitioner of musculoskeletal medicine. In fact, if the patients' interests are to be truly served, there needs to be co-operation by members of all branches of the medical and paramedical professions (notably those in the investigative specialties and those who specialise in particular forms of management such as orthopaedic surgeons, rheumatologists, rehabilitation consultants and physiotherapists). However, there is a particular role clearly defined for the practitioner of musculoskeletal medicine, be he a general practitioner with a special interest or someone practising full-time in a musculoskeletal field. That role is to undertake a competent assessment of the patient's condition and to decide on an appropriate management strategy. Whether he then undertakes part of that management himself, or refers the patient to others for particular forms of treatment, is of secondary importance. As our submissions have repeatedly stated, the service most lacking from the medical armamentarium in relation to musculoskeletal complaints is the service of providing a comprehensive, objective and reliable assessment of the patient's problems.

Of course, such an assessment must be based on a specific body of knowledge and familiarity with certain clinical procedures and ancillary investigations. Further, it is not just a matter of possessing particular knowledge and skills, but of understanding their relevance and being able to discriminate so as to apply those most appropriate in a given set of circumstances.



To these ends, the Association has expended a great deal of effort over recent years in the delineation of the special body of knowledge and the description of the various assessment techniques, ancillary investigations and management procedures which need to be understood by the practitioner who would undertake musculoskeletal problem-solving. One result of the Association's work in this field was the publication of its syllabus of musculoskeletal medicine last year. Since then it has used the syllabus as a basis for developing members' knowledge and skills.

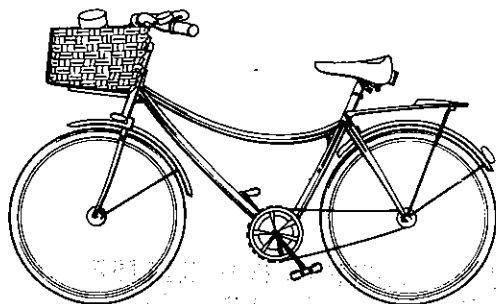
The last annual scientific meeting could fairly be described as the syllabus in action, leading members through a revision of some relevant areas of the basic sciences and presenting them with new facts resulting from recent research. The process is set to continue at this year's conference, when the very practical subject of injections in musculoskeletal medicine will be tackled in a similar way.

Another manifestation of the syllabus in action is the material published in recent editions of the Bulletin. This issue contains papers by some of those who spoke at last year's conference, describing and summarising some of the topics addressed there. It also continues the policy of printing relevant abstracts gathered from the many journals around the world which touch on musculoskeletal subjects. It is believed that these abstracts provide a valuable source of reference, enabling interested members to keep in touch with many facets of musculoskeletal science and practice.

Other developments made possible by the Association's recent achievements and current policies include the upgrading of both undergraduate and postgraduate educational programmes and the institution of recognised postgraduate qualifications in the discipline. These possibilities have been exercising the minds of many for years but it was not until recently that the Association felt it had sufficient runs on the board to enter into serious discussions with appropriate tertiary institutions. Negotiations are still under way and their outcome will depend to some extent on how the membership wishes the Association to move in the future.

No doubt other projects also need to be considered to take full advantage of the present impetus. The A.A.M.M. is, after all, essentially the sum of its members and each member should give thought to the way he would like to see its future develop and bring some ideas to the coming Annual General Meeting.

MOBILITY. VOLTAREN PATIENTS ARE VERY RELAXED ABOUT IT.



Voltaren
(diclofenac sodium)

A PRESCRIPTION FOR RELIEF.
NHS Unrestricted Benefit:
25mg & 50mg tablets.

For product information see page

® Registered Trademark 09/88 C-G613/CJBJ

From The Hon. Secretary's Desk

From the Hon. Secretary's Desk



The theme of our forthcoming conference is Injections. This should be of great practical interest to many journal readers, and I feel there is always something new to learn in this field.

One of my early recollections of injection techniques is a visit to Dr Peyto Slatter, an English orthopaedic physician in Southern England. He, together with Dr Ron Barber, has been a prime mover in the use of sclerosant injections in the treatment of "lumbar instability".

I sat in with him for a day or so. He performed a number of caudal epidurals for sciatica, and did one paravertebral cortisone block in the neck for an elderly patient with chronic unilateral neck pain with referred pain into the arm. These injections appeared straight forward.

However, the other injections appeared more difficult. Firstly, there was the sclerosant, where a mixture called P24 is injected onto bone in multiple sites - L4/5/S1 spinous processes, L5 transverse process, sacro-iliac joint, ilio-lumbar ligament, etc., with a long needle. He gave the patient some nitrous and oxygen, and performed the technique with skill and brevity indicative of copious experience. Some of the patients were having repeat sclerosants - always a good sign of reasonable results in the part - so it seems that the technique can have a benefit. Dr Bosler and Dr Pitts perform this in Australia, and there will be a session on this at the conference.

The second difficult injection he performed was on a lady with phantom limb pain related to one absent leg. She used to attend for a six weekly lumbar sympathetic anaesthetic and steroid block. He used an enormous needle and inserted it so that it hit the vertebral body at mid point, and then he marched the needle anteriorly, injecting onto bone as he went. The lady stayed attentive, and reported when the injection was stimulating the limb pain, and into that spot he injected the local and steroid. She said that this injection afforded good relief for variable periods.

I have treated many patients by the use of epidural and shoulder injections, and for guidance in regard to indications and methods I have the teachings and books of James Cyriax to thank more than anything else.

I would hope that we can all learn more about the safe application of injections at our next conference.

David Vivian



A cheerio call to someone selected
at random from the membership barrel

This time the call goes up to Queensland again, in fact to a well-known musculoskeletal address in Brisbane where **Bob Michael** practices in association with **Gordon Byth**. Bob joined the practice when Carl Rotkirch and his wife Biddy decided to spend some time practising in Arabia.

When he is not solving musculoskeletal problems, Bob and his wife Sue spend a lot of their time tending the macadamia trees on their farm, which must surely be one of the last rural holdings in the Brisbane suburban area (apparently nuts are one of the few things which are respected by land developers in the curious Queensland socio-political system).

Gordon and his wife Joy have no overt connecton with nuts but there is room for doubt when Gordon's track record is taken into account. As a founding member and Past President of the A.A.M.M., Gordon is one of the few who has been heavily involved with the Association since its inception and that alone should be grounds for suspicion.

1987 ANNUAL SCIENTIFIC MEETING REPORT

In October 1987, the Annual Scientific Meeting of the AAMM was held in conjunction with the NZAMM and the Australian Spinal Research Society. The highlight of the meeting was a symposium on "The Biology of the Lumbar Disc". This symposium was designed as a comprehensive and detailed teaching session on this topic. The lectures were designed to review all current knowledge on the lumbar disc, and ordered to provide a description of how normal structure is affected by age and injury, leading to an explanation of how discs can become a source of pain, and how this pain might be managed.

In the first session on the Saturday morning, three lectures were given which outlined the structure and development of the disc, and to outline basic principles of biochemistry and biomechanics. The latter two lectures were designed to provide definitions of terms and concepts that would be used and developed in later lectures. In the second morning session, the normal movements and biomechanics of the lumbar spine were described in order to set the context for interpreting abnormal and damaging movements which were to be addressed later.

In the first afternoon session on Saturday, the lectures still addressed the normal, uninjured disc, but focussed on how the disc changes with age. The object was to clarify that certain changes that occur in discs are due simply to age, and should not be construed as pathological. The final afternoon session addressed the pathology of disc pain. In this session, all the concepts that had been introduced previously in the context of normal discs were marshalled to explain how discs could be injured and become painful; how excessive ranges of movement could damage the annulus fibrosus, and how alterations in the biochemistry of the disc could result in pain. The object was to explain how the disc itself could become a source of pain, in the absence of disc herniation. In fact, the session specifically avoided any consideration of disc herniation; the intention being to withdraw attention to this over-emphasised condition, and to focus on new data on the putatively more common intrinsic disc lesions as sources of back pain.

Having established a model of the pathology of painful discs on the Saturday, the Sunday session turned to clinical issues: how the painful disc might be detected and how it might be treated. The first Sunday session addressed the radiological diagnosis of intrinsic disc lesions, and the concluding session addressed their surgical and conservative management.

In the last issue of the Bulletin (Vol.4, No.2, 1988) we published the first three papers of the Symposium. These were by Jim Taylor on "The development and adult structure of lumbar intervertebral discs"; by Peter Ghosh on "Basic biochemistry of the intervertebral disc and its variation with ageing and degeneration"; and by Janet Macintosh on "Basic biomechanics pertinent to the study of the lumbar disc".

In this issue we continue the series with two papers on the age changes in the disc and its biochemistry.

The first paper is by Lance Twomey who is Professor of Physiotherapy at the Curtin University of Technology in Perth. Age changes of the lumbar spine was the topic of Lance's PhD thesis and remains one of his current research interests.

The second paper is by Dr Peter Ghosh, who is a biochemist, Director of the Raymond Purves Laboratories at Royal North Shore Hospital, Sydney, and Associate Professor in the Department of Orthopaedic Surgery in the University of Sydney. He is an internationally respected researcher in the field of connective tissue biochemistry, and apart from interests in cartilage biochemistry he has published extensively on biochemistry of the disc and the chemistry of scoliosis. He is the editor of a book on "The Biology of the Disc", published by CRC Press and released in March 1988.

The third paper is by Professor Bill Hutton who is Head of the School of Mechanical Engineering at the South Australian Institute of Technology. Prior to coming to Australia, Professor Hutton undertook a series of systematic studies of the biomechanics of lumbar intervertebral joints, and his paper summarises this work. In 1981 Professor Hutton was the recipient of the Volvo Award for Back Pain Research in the category of Basic Sciences for his work on intervertebral disc prolapse.

Nik Bogduk
President, AAMM and ASRS

The 1988 Annual Scientific Meeting will be held in Newcastle, on 2nd - 4th December, not on the weekend before as advertised in the May Bulletin. The change of dates was necessitated by examination arrangements at the main venue, the University of Newcastle Medical School building at the Royal Newcastle Hospital.

The theme for this year's conference is Injections in Musculoskeletal Medicine and the aim is to present new information and to encourage discussion on practical aspects of the uses of injections in both assessment and treatment. No doubt there will be some interesting points raised and it is hoped that all who attend will leave the meeting better (i.e. safer and/or more appropriate) injectors as a result of the proceedings.

The meeting will also serve to demonstrate one application of the syllabus adopted by the Association last year. Topics to be addressed are essentially those outlined in the sections of the syllabus dealing with injections and members should find that the pertinent issues are well and truly canvassed in the course of the weekend.

A detailed programme for the conference will be found on the Meetings, Conferences and Courses pages of this issue.

* * * *

The Conference Dinner will be held in a winery a short distance away from Newcastle and members will be transported there and back by bus. Shades of Adelaide in 1985, Tamworth in 1983 and sundry other memorable occasions! The time to begin tuning vocal cords is now.

* * * *

The news is that there is no news to report yet on the establishment of a formal course on musculoskeletal medicine in Australia. Negotiations are continuing in several quarters and have included consideration of courses for interest only or to certificate, diploma or degree standard. No doubt it will be one of the issues to come up for further discussion at the A.G.M. in December.

* * * *

Meanwhile, the New Zealanders are pressing ahead with preparations for their diploma course in musculoskeletal medicine, to be offered by the University of Otago. It is due to begin next year.

* * * *

The enthusiastic efforts of **Marius Loeffler** have resulted in a resurgence of A.A.M.M. activity in Western Australia. Marius has been very active in promoting the Association to colleagues in that state and his exertions have led to a considerable increase in Westralian membership. A programme of meetings is well under way and plans are afoot for eastern state members to travel over and lend their efforts in support.

* * * *

At the recent Winter Meeting at Mount Buller **Howard Farrow** set such a cracking pace on the slopes that he literally skied his boots to pieces. Not to be fazed, he promptly hired some more to keep himself in action whilst a local supplier prepared a new pair of European design so special that the inner lining has to be poured and moulded to fit the wearer's feet exactly. The rest of the party were slightly overawed by all of this: they were enthusiastic too, but no-one else so much as twisted a boot clip.

* * * *

The resource material for the very successful courses on "Spinal Manipulation for Doctors", run by **Clive Kenna** and **John Murtagh** under the auspices of the R.A.C.G.P., has been consolidated with a great deal of extra information into book form. The work is to be published early next year by Butterworths under the title "Back Pain and Spinal Manipulation: A Practical Guide".

* * * *

Norm Broadhurst, who generally manages to look fit and tanned despite the Adelaide climate in which he lives, has a special reason for looking that way lately. He has recently returned from a cruise through the Whitsunday Passage on H.M.A.V. Bounty. By all accounts the treatment received by the ship's company was not such as to incite them to mutiny, unless some were tempted to mutiny against their normal life-styles and run away to sea. One wonders if there is any truth in the rumour that Norm has since been seen pacing the quarter-deck of H.M.S. Buffalo anchored at the dock near his surgery in Glenelg.

* * * *

Members will be pleasantly surprised to hear that **Alex Ganora**, long-time stalwart and former Treasurer of the Association, has returned to private practice. As many would know, Alex has spent the last several years developing the concept of private multi-disciplinary rehabilitation facilities, beginning with the Illawarra Rehabilitation Centre. It was feared that his considerable talents would be lost to musculoskeletal medicine as his success in the rehabilitation hospital field led to him becoming more and more involved in the administrative side of health facility management. These fears have proved groundless, however, and he recently resumed private practice as a specialist physician in physical and rehabilitation medicine at 149 Macquarie Street, Sydney, [telephone (02) 241 1321].

* * * *

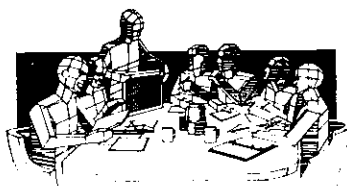
Subscriptions for 1988-89 are now due and members are requested to send a remittance of \$45 to the Hon. Treasurer. There would be a considerable saving of both effort and money if this could be done without the need for sending a formal subscription notice, but notices will be sent out if necessary. Canny members will send their cheques before the annual conference as the fee will be reviewed as usual at the A.G.M. and any increase would apply after that date.

There is no need to write a formal letter to send with the subscription: a "with compliments" slip or any scrap of paper with the member's stamp showing name and address and the words "A.A.M.M. subs." will more than suffice. Please draw attention to any change of address, etc., that has occurred recently.

Those who wish to be really canny and send their subs. in with their conference registrations, thereby saving a stamp, are asked to include a slip clearly denoting the subscription payment.

* * * *

With the next triennial F.I.M.M. Congress now only twelve months away, some members will no doubt be starting to think about travelling to London to make or renew acquaintances with international colleagues and to hear the latest information on a variety of relevant topics. Anyone who is contemplating attending a F.I.M.M. Congress for the first time, or anyone interested in joint travel arrangements, or for that matter anyone who would just like some further information, should contact the Hon. Sec.



MEETINGS, CONFERENCES AND COURSES

LOCAL AAMM MEETINGS

In **Sydney** meetings are held at 7.30pm on the third Monday of each month in the Department of Rehabilitation Medicine, Royal Prince Alfred Hospital. The programme usually consists of a lecture or discussion on a selected topic, followed by case presentations and a practical session of diagnostic and management techniques. The meetings are open to all interested medical practitioners. Those wishing to attend are asked to telephone (02) 27 8926 during the preceding three working days to confirm the arrangement.

In **Melbourne** monthly clinical meetings are held at the Metropolitan Spinal Clinic, 302 Malvern Road, Prahran, usually on the last Friday of each month. These meetings include patient presentations and clinical lectures. Those interested are invited to contact the clinic for further details, on (03) 529 1988.

Regular meetings, practical sessions and courses are conducted in many other centres around Australia by state branches, local groups and individual members of the Association. These activities are mainly for the benefit of members living in a particular area and they will generally be advised by letter or by local notices of dates, times and venues. Anyone who is not receiving information about local activities, or who would like more details about what is going on, should contact one of the local organisers listed below.

In **Adelaide**, Dr. Norm Broadhurst, telephone (08) 295 1890.

In **Ballarat**, Dr. Jim Rose on (053) 35 7366.

In **Brisbane**, Dr. Carl Rotkirch on (07) 344 1022.

In **Canberra**, Dr. Goff Nelson on (062) 95 6773.

In **Hobart**, Dr. Ron Heddle on (002) 34 5990.

In **Melbourne** and **Geelong**, Dr. David Vivian on (03) 596 7211.

In **Newcastle**, Dr. Nik Bogduk on (049) 68 5699.

In **Perth**, Dr. Marius Loeffler on (097) 33 5220.

In **Sydney**, Dr. Conrad Winer on (02) 27 8926.

In **Taree**, Dr. Wade King on (065) 50 5167.

In **Toowoomba**, Dr. Jeff Phillips on (076) 38 4800.

In **Townsville**, Dr. Roger Watson on (077) 71 3084.

Those who live in other areas and who would like to organise or participate in local meetings should contact one of their state representatives, who can arrange publicity and other assistance from the resources of the Association.

ANNUAL GENERAL MEETING

The Annual General Meeting of the Australian Association of Musculoskeletal Medicine will be held at 4pm on Saturday, 3rd December, 1988 in the David Maddison Lecture Theatre, Royal Newcastle Hospital.

As usual, the A.G.M. will take place during the Association's annual conference, full details of which will be found on following pages.

OTHER AUSTRALIAN MEETINGS

Numerous meetings on topics of relevance to musculoskeletal medicine are held throughout Australia by groups allied to the A.A.M.M. Members are specifically invited to attend many of these and they are advertised in the Bulletin on a reciprocal basis. Some of those coming up include the following.

October 3-4, 1988. **Sydney.** Annual Conference of the Australian College of Sports Physicians. Contact P.O. Box 247, Grosvenor Street, Sydney, 2001.

October, 1988. **Various centres** Australian lecture tour by Jane Barefoot, U.K. physiotherapist with special interest in the physical therapy management of patients with ankylosing spondylitis. Contact Arthritis Foundation of Australia, 64 Kippax Street, Surry Hills, NSW 2010, telephone (02) 281 1611.

November 29, 1988. **Sydney.** Back Problems in Occupational Medicine, a meeting conducted by the Postgraduate Committee in Medicine, University of Sydney, in conjunction with the Australian College of Occupational Medicine. Contact Postgraduate Committee in Medicine, Copleston Institute D02, The University of Sydney, NSW, 2006, telephone (02) 692 3526.

December 10, 1988. **Sydney.** Neurology Refresher and Update including sessions on arm and leg pain, neurological assessment of the limbs, etc. Contact Centre for Continuing Medical Education, University of New South Wales, P.O. Box 1, Kensington, NSW, 2033, telephone (02) 697 3061.

February 6-10, 1989. **Sydney.** Health, Fitness and Exercise in Clinical Practice. Contact Centre for Continuing Medical Education, University of New South Wales, P.O. Box 1, Kensington, NSW, 2033, telephone (02) 697 3061.

February 13-17, 1989. **Sydney.** Sports Injuries, Their Prevention and Management. Contact Centre for Continuing Medical Education, University of New South Wales, P.O. Box 1, Kensington, NSW, 2033, telephone (02) 697 3061.

MEETINGS OVERSEAS

November 4-6, 1988, **Rotorua, New Zealand** - Annual Conference of the New Zealand Association of Musculo Skeletal Medicine. Contact: Dr P Watson, 36 Ensign Street, Christchurch 3, NZ.

November 7-12, 1988, **Bangkok, Thailand.** 3rd International Conference on Musculoskeletal Accidents in the Workplace.

November 11-14, 1988. **Palm Springs, USA.** The Spine: Current Concepts of Diagnosis and Treatment. Contact: Dr. M Nordin, 301 East 17th Street, 14th Floor, New York, NY 10003, USA.

November 14-17, 1988. **Basel, Switzerland.** Biosterometrics '88. Contact: Program Committee, PO Box 10, Bellingham, WA 98227-0010, USA.

December 9-10, 1988. **Singapore.** 5th International Conference of Biomedical Engineering. Contact: 5th BIOMED, Department of Orthopaedic Surgery, National University Hospital, 5 Lower Kent Ridge Road, Singapore 0511.

April 14-15, 1989. **London, UK.** The Changing Role of Engineering in Orthopaedics. Contact: Andree Johnson, Conference Department, C384, The Institution of Mechanical Engineers, 1 Birdcage Walk, London SW1H9JJ, UK.

June 26-30, 1989. **Los Angeles, USA.** XII International Congress of Biomechanics. Contact: XII ISB Congress Secretariat, Department of Kinesiology, 2854 Slichter Hall, UCLA, Los Angeles, CA90024-1568, USA.

September 18-22, 1989. The Ninth Triennial Congress of F.I.M.M. (Federation Internationale de Medicine Manuelle), the international body with which the A.A.M.M. is affiliated, will be held at the Kensington Town Hall, **London, U.K.** Programmes and registration forms will be sent to members in due course. Further details at this stage may be obtained from the Hon. Sec. or by writing to Conference Associates FIMM, 27A Medway Street, London SW1P 2BD, United Kingdom.

THE EIGHTEENTH ANNUAL SCIENTIFIC MEETING
of the
AUSTRALIAN ASSOCIATION OF MUSCULOSKELETAL MEDICINE
 will be held at the
David Maddison Lecture Theatre, Royal Newcastle Hospital,
NEWCASTLE, NSW,
 on
2nd - 4th December, 1988

THEME: Injections in Musculoskeletal Medicine

PROGRAMME

FRIDAY, 2ND DECEMBER, 1988

- 8.30am - 12.00md **Pre-Conference Demonstration of Fluoroscopic Injection Techniques** at the Mater Hospital, Rankin Drive, Waratah, Newcastle (for practical reasons only limited numbers can be accommodated and preference will be given to those who apply early).
- 7.30pm **Cocktail Reception** at the Newcastle Beach International Hotel, Shortland Esplanade, Newcastle.

SATURDAY, 3RD DECEMBER, 1988

- 8.30am - 9.00am **Registration** in the David Maddison Theatre foyer.
- 9.00am - 9.30am **The Power of the Needle.** *Dr. Nik Bogduk.*
- 9.30am - 10.00am **Injection Complications and their Management.** *Dr. Peter Armstrong.*
- 10.00am - 10.30am **Epidural Injections.** *Dr. Clive Kenna.*
- 10.30am - 11.00am **Discussion: What is a Safe Injection?**
- 11.00am - 11.30am *Morning tea.*
- 11.30am - 12.00md **Stellate and Lumbar Sympathetic Blocks.** *Dr. Tim McCarthy.*
- 12.00md - 12.30pm **Facet Joint Injections.** *Dr. Nik Bogduk.*
- 12.30pm - 1.00pm **Discussion: Who Needs Fluoroscopy Anyway?**
- 1.00pm - 2.00pm *Lunch.*
- 2.00pm - 2.30pm **Cervical Radiofrequency Denervation.** *Dr. Nik Bogduk.*
- 2.30pm - 3.00pm **Lumbar Radiofrequency Denervation.** *Dr. David Vivian.*
- 3.00pm - 3.30pm **Discussion: Why Radiofrequency Denervation?**
- 3.30pm - 4.00pm *Afternoon tea.*
- 4.00pm - 5.30pm **Annual General Meeting of the A.A.M.M.**
- 6.15pm *Bus departs Newcastle Beach International for Pokolbin.*
- 7.30pm **Conference Dinner** at Tulloch's Vineyard, Pokolbin.

SUNDAY, 4TH DECEMBER, 1988

- 9.00am - 9.30am **Trigger Points.** *Dr. Wade King.*
- 9.30am - 10.00am **Sacro-Iliac and Pelvic Injections.** *Dr. Norm Broadhurst.*
- 10.00am - 10.30am **Sclerosant Injections.** *Dr. Brendan Pitts.*
- 10.30am - 11.00am **Discussion: Do Trigger Point Injections and Sclerosants Really Help?**
- 11.00am - 11.30am *Morning tea.*
- 11.30am - 12.00md **Shoulder Assessment and Injection Therapy.** *Dr. Norm Broadhurst.*
- 12.00md - 12.40pm **Film: Straight To The Joint.** *Dr. Brian Corrigan.*
- 12.40pm - 1.15pm **Discussion: Injection Techniques in Perspective.**
- 1.30pm *Picnic lunch in a park near the beach.*

The organising committee has pleasure in inviting you to Newcastle for the A.A.M.M.'s eighteenth annual conference. As in past years, the meeting will provide opportunities for discussion of a wide range of issues of interest to members. However, it was decided that the emphasis should be placed this year on practical aspects of musculoskeletal assessment and treatment. Accordingly, **Injections in Musculoskeletal Medicine** has been chosen as the theme of the meeting.

This was done for two reasons: to introduce to members recent work and new techniques directly relevant to everyday clinical procedures and to demonstrate in action the syllabus adopted by the Association last year. Hopefully the material presented at the conference, and the discussions that take place there, will address the significant issues of those sections of the syllabus dealing with the use of injections. Conference participants should leave Newcastle with some fresh ideas and a new perspective of the safe, effective and appropriate use of injection techniques in musculoskeletal practice.

ACCOMMODATION

There are many hotels and motels in the inner Newcastle area close to the conference venue. Three that have been approached for special rates for conference visitors are:

Newcastle Beach International

Shortland Esplanade, Newcastle, NSW, 2300.
telephone (049) 29 5181

This is a high quality hotel right on Newcastle Beach and three blocks (along the beach) from the main conference venue. The hotel is the venue for the Cocktail Reception at which delegates will be welcomed to the conference on the Friday evening. Tariff (special conference rate) \$64 per double room.

Newcastle Top Of The Town

Shortland Esplanade, Newcastle, NSW, 2300.
telephone (049) 29 5576.

This is another high quality establishment, adjacent to that above with similar beach access and proximity to the main conference venue. Tariff (special conference rate) \$65 per double room.

Terminus Motel

107 Scott Street, Newcastle, NSW, 2300.
telephone (049) 26 3244.

Well appointed accommodation is offered in this recently refurbished motel at inexpensive rates. Located across the street from Newcastle Railway Station and two blocks from the main conference venue, it resembles a traditional Australian hotel but has all mod. cons., including private facilities in all rooms. Tariff (special conference rate) \$39 single, \$45 double.

Conference delegates are advised to book accommodation as soon as possible as a major surfing contest will be held at the same time as our meeting. When booking, mention "conference at University" to obtain the special tariff.

CONFERENCE REGISTRATION FORMS SHOULD BE RETURNED BY 15TH NOVEMBER.

For further details or enquiries, contact:
Dr. Wade King,
P.O. Box 1044, Taree, NSW, 2430.
telephone: (065) 50 5167

1988 WINTER MEETING REPORT

Like Abraham of old, the Winter Meeting party travelled to the mountain full of faith, and like Abraham they were not disappointed.

A.A.M.M. Winter Meetings are not, and were never intended to be, academic or scientific gatherings. The Association has plenty of those and in recent years they seem to have become much larger and more high-powered. That is progress and none would oppose it. However, it has inevitably eroded some of the "clubby" social atmosphere of the small conferences held in the Association's earlier days. That seems a pity, for the Association has as well as for individuals, as personal relationships are important in a craft group like the A.A.M.M. with members dispersed over a continent the size of Australia.

When this point came up in a conversation at the 1986 Annual Conference in Sydney, the suggestion was made that an extra meeting be held, primarily for members to spend some time together socially. From this grew the Winter Meetings, when members gather at a ski lodge at Mount Buller in Victoria, many with their spouses and families, to share a week of skiing and conviviality. Inevitably there is some "shop talk", and even some discussions that would not be out of place at a scientific meeting, but they are not planned. The Winter Meeting is not meant to be either an academic conference or a "rort", but simply a week of social fellowship for people of like mind who share similar interests. These modest aims have certainly been achieved at both gatherings held so far and after their successes it seems that annual Winter Meetings have a secure future.

The 1988 Winter Meeting had something of an uncertain beginning. As members in various states packed their ski gear in the days before the meeting was due to begin, it was in the knowledge that the winter was unusually warm and dry. In fact, there was absolutely no snow at Mount Buller and the ski lifts had not been operating for some weeks. After much consideration some members decided not to make the trip. Others decided to go anyway, placing their trust in long-range forecasts or else simply in divine providence for a change in the weather; several expressed the thought that the mountain air and the fellowship would make the trip worthwhile even without snow.

As it turned out, those relying on divine providence were entirely justified. As the first members to arrive reached the park gates at the foot of Mount Buller they were told it had begun to snow further up. This was confirmed by light, and then heavy, snow on their windscreens as they drove up the mountain. By the time the top car-park was reached snow on the road was a problem and some were even held up by road closures due to snowdrifts.

The very keen went straight onto the slopes as soon as they could get their skis on and conditions were already more than adequate, the only problem being the continuing blizzard. Snow fell all that first day and night, and when it eased off next morning conditions were really good, with fifty centimetres of fresh cover and a clear sunny sky. Things improved further still as the week went on: the early snow settled to form a base and the surface was topped up with fresh powder which mainly fell at night, as if by order.

Despite the initial climatic uncertainty, members were present from all the eastern states. Howard Stevens and his wife Kerri took the prize for having travelled the furthest to attend: they had come all the way down from the tropical rainforest country of Cairns. Kerri was also voted the most determined beginner, venturing out onto the snow apparently without regard for the cold, despite obvious problems in acclimatising, and demonstrating a grace on skis that could only be achieved with natural talent. Howard Farrow, from Melbourne, was undoubtedly the most proficient skier and also, incidentally, the best dressed and equipped. While most members of the party were content to enjoy the scenic beauty of runs like Little Buller Spur, Whisky Creek Trail or the Summit Bowl, Howard was clearly a little disappointed that there was not quite enough snow to get the full value out of the most difficult runs like The Funnel, Falline and Bloody Hell.

The atmosphere in the lodge can be easily imagined, although just why grown people would want to sit up until the early hours of the morning playing ridiculous card games, when they were really tired out of their minds after a hard day's skiing, defies explanation. It must have something to do with crackling fires and apres-ski imbibing.

Members who have not yet savoured such delights, or at least not in such exceptional company, and who would like to share the experience next year (and all at a remarkably low cost) should mark off the last week of July in their 1989 diaries and watch for details in the next Bulletin of the 1989 Winter Meeting.

The secretariat of F.I.M.M. has sent the following information about two special awards offered for papers to be presented at the Ninth Triennial International Congress of F.I.M.M. in London from 18th to 22nd September, 1989.

F.I.M.M. AWARDS

Purpose:

Encouragement of experimental and clinical research in areas related to musculoskeletal medicine

Award Values:

One experimental and one clinical paper will each be awarded \$3000.

Conditions:

To be eligible papers must be original and either unpublished or published in the journals "Manual Medicine" or "Manuelle Medizin" within the time between the Eighth and Ninth F.I.M.M. Congresses.

Papers should be submitted in the English language with the full text including figures and references set out according to the instructions issued by Springer publications.

Five copies of each paper should be submitted. Research contributions consisting of different papers related to the same subject will be acceptable.

The Awards are open to qualified medical practitioners including M.D.'s and D.O.'s, and also D.C.'s and Ph.D.'s.

Awards Committee:

The judging committee will be appointed by the General Assembly of F.I.M.M. and will consist of five members who are respected for their scientific activities. The voting procedure will be anonymous.

Resources:

The national associations of manual medicine or musculoskeletal medicine which comprise the F.I.M.M. membership each contribute \$200 per annum to F.I.M.M. funds, from which such awards can be made.

Presentation and Publication:

It is mandatory that the winning papers be presented at the Ninth F.I.M.M. Congress in London.

Winning papers will also be published in full in the journal "Manual Medicine" and in German translation in "Manuelle Medizin".

Submission:

Papers should be submitted before 1st May, 1989, to the Secretary of F.I.M.M., H. Baumgartner M.D., Wilhelm Schulthess Hospital, Neumünsterallee 9, CH-8008 Zurich, Switzerland.



Shoulder Rehabilitation: A Clinical Observation

Dear Sir,

Over a period of time I have found that a particular approach to the frozen shoulder syndrome has given consistently satisfactory results. It is a hybrid of various accepted techniques which appear to allow the pathology of shoulder joint function to be corrected in a co-ordinated and integrated fashion.

Results are dramatic in some circumstances, often with markedly improved pain-free movement being achieved in the course of the first consultation. Sleep disturbances due to pain also tend to remit rapidly.

The technique is simple. It is an integration of isometric muscle strengthening, muscle action, and subcortical postural reflex behaviour of the upper quadrant. Pain, as a reflection of decompensation, is eliminated when this is done.

In practice the patient must be taught all the basic principles and encouraged to assume the role of "the pain-free self healer".

The approach can be divided into three merging phases:

Body awareness

1. Concentration of the fingers and hand is mandatory, and must be maintained at all times.
Posture is basically a subconscious activity, subservient to cortical needs. As soon as concentration during a movement focusses on the shoulder the movement becomes abnormal.
2. The fine movements must be established first.
3. Equilibrium must be established between the two sides and then within the whole body.
4. All positions and movement must be pain free. Pain indicates a pathological movement or posture, and maintaining such merely enhances the pathology.
5. Starting points should be varied.
This creates the potential of re-establishing the complete range of movement.
6. Posture may be varied.

Strengthening

7. Increase the opposing forces while at the same time taking a deep breath, till maximum is reached.
8. Maximum includes all auxiliary muscles from the toes up.

Stretching

9. Combined with a deep expiration the hands should be moved in the opposite direction to the isometric force. Again the whole body should be allowed to flow into the movement. (Ideally, the movement is combined with an aim-"reach for the sky", "spread your hands out behind you", etc. The movements should be childlike - in describing this to patients I often compare the process to that which the child goes through in establishing his natural hand movements).
10. Maximum movement to the end point should include the maintenance of the stretch for 6-10 secs.

The basic consultation takes me approximately 30-45 minutes. I usually start with the patient standing, elbows flexed and the fingers spread and lightly touching. I explain that the aim is to teach the hand to become useful and describe how the shoulder normalises automatically when the whole forequarter function becomes integrated.

Stress is placed on the importance of the hand, as the major input of sensation, in reflex activity and for its prominent representation in the sensory and motor cortices.

The fingers should be comfortably spread and the patient encouraged to feel the sensation of touch, appreciate the balance of forces necessary to maintain stability, and the feelings of fine movement, by slowly and smoothly moving a few millimetres to one side then the other, then rotating the hands to see first the nails then the pulps, all the time keeping the tops just touching.

Time must be taken over these finest of movements. Often they have a fine tremor which disappears as the technique progresses.

When ready, pressure can be built up, all the time feeling the equality and smoothness of sensation in the fingers, hand and wrist, pushing and relaxing, and not advancing till comfortable with the situation. As the pressure builds the patient takes a deep breath and you encourage him to adopt the normal auxillary posture by flexing his body, bending the knees and coming onto his toes.

As he exhales he reaches back, extending the body, and holds the stretch for 6-10 seconds.

The same procedure is then performed varying the starting point, always maximising the importance of the initial sensations, the feelings of stability in the build-up and stretching to the opposite direction.

I usually work lower at the level of the umbilicus and pubic region, anterior thigh, and sometimes the knee, then laterally to the thighs, hips, buttocks, lower back etc. I then work up over the head, the hands either feeling each other or the part of the body they are contacting.

Conceptually, it is often easier to imagine various situations to combine with the stretch to enhance the cortical component such as "reach for a balloon", "spread your arms back" etc.

Later you can start from a unilateral point. I usually leave this for a later session and often have found the patient has already worked it out for himself, including the appropriate background posturing.

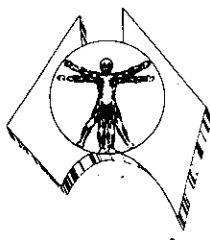
I can not justify this approach by providing a controlled series but in clinical practice I have found it to be a significant improvement on other treatments available in a difficult management situation.

Yours faithfully,

(Dr.) Barry Abeshouse

The method sounds most interesting. Other members' comments on it would be welcome, as would similar clinical observations on other subjects.

- Ed.



STRUCTURAL & MECHANICAL DISC CHANGES WITH AGE

by

L Twomey

Curtin University of Technology

J Taylor

University of Western Australia

Abstract: This descriptive paper considers the changes which occur in the shape, structure and mechanical behaviour of the lumbar intervertebral discs with increasing age. Contrary to common clinical thought, lumbar discs usually maintain their central height through life, although they become more convex on the end-plate surfaces as they conform to the often profound changes which occur in the lumbar vertebral bodies in old age.

The usual patterns of circumferential and radial fissures in the anulus fibrosus are described and the creep/hysteresis behaviour of the discs to prolonged loading is considered. It is proposed that postures under load, sustained at the limit of a lumbar range, should be avoided.

Primary Structural Change:

The primary structural change which occurs in the lumbar spine with increasing age is a decline in the number of transverse trabeculae within the vertebral bodies, leading to a decline in the height of the lumbar vertebrae and an increase in end-plate concavity (Twomey et al, 1983). This, in its turn, brings about a complementary change to the shape of the intervertebral discs, and contributes to a reduction in lumbar lordosis, and a reduction in the ranges of lumbar movements, as in Figure 1 (Twomey and Taylor, 1985; 1986). Thus, the vertebrae and discs "sink into each other" in old age, as the compressible discs adjust to the often profound shape changes occurring in lumbar vertebrae.

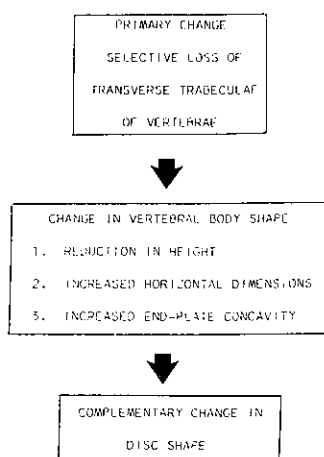


Figure 1. Flow chart indicating the result of the primary structural age change which occurs in the lumbar spine with increasing age.

Intervertebral Discs:

The prevailing clinical assumption that the loss of stature which occurs with increasing age (Stenhouse, 1972) is due in large part to thinning of intervertebral discs has been shown to be incorrect in recent studies (Nachemson et al, 1979; Twomey and Taylor, 1985). Average disc height is usually maintained and may even be increased in old age (Figure 2), confirming the data from previous studies demonstrating that loss in vertebral height is the principal reason for loss in stature (Twomey, 1981; Ericksen, 1974, 1975).

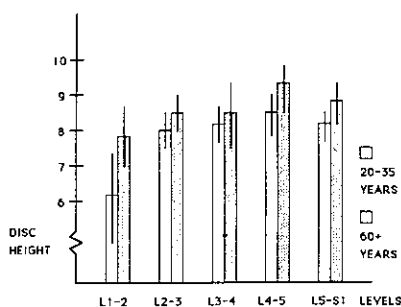


FIG. 2. THE INCREASE IN "TRUE-AVERAGE" DISC HEIGHT (IN MMS) BETWEEN THE AGES OF 20-35 YEARS AND 60+ YEARS IN FEMALES. (THE DATA FOR MALES IS SIMILAR - SEE TWOMEY & TAYLOR, 1985.)

Figure 2. The increase in "true-average" disc height (in mms) between the ages of 20-35 years and 60+ years in females. [The data for males is similar - see Twomey & Taylor, 1985.]

When the data for disc height with increasing age is carefully considered, it is evident that the increase in central disc height, as measured on mid-line sagittal section, is greater than the small decline in anterior and posterior disc heights. This latter phenomenon occurs as a direct result of the vertebral body age changes described above and also due to the increase in peripheral osteophytosis and the marginal bony hypertrophy due to traction forces exerted by the anulus fibrosus on the vertebral margin (Figure 3). The tough intervertebral disc adapts gradually to this change in vertebral body shape.

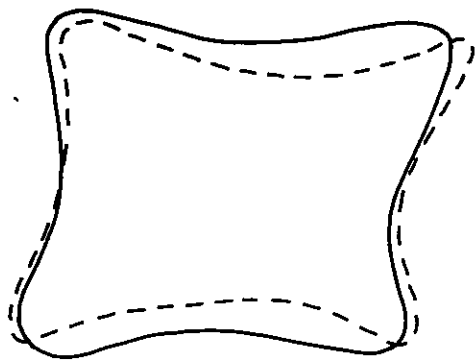


Figure 3. Changes in vertebral body shape with increasing age. The solid line represents a tracing of a L3 vertebral body from a typical 22 year old male, while the dotted line represents a similar tracing from a 74 year old male.

"Disc degeneration" is a term which is often ill-defined in the literature, where it may be used synonymously with anular fissures, or disc thinning, or colour change, or the presence of osteophytes at the joint margins, and is often considered universal in old age (Armstrong, 1967; Schmorl and Junghans, 1972). In 1966, Rolander provided a morphological classification of intervertebral discs based on their appearance on mid-line sagittal section as follows:

- Grade 0 : macroscopically normal, juvenile discs;
- Grade 1 : normal adult discs, white in colour, the nucleus bulges on section;
- Grade 2 : age changes; less distinct boundary between nucleus and anulus, yellowish colour;
- Grade 3 : frank disc degeneration with dessication, multiple fissures in nucleus and anulus, disc thinning.

On the basis of this commonly accepted and utilised classification, it is very clear that the majority of elderly discs do not suffer disc degeneration as so defined. In a previous study (Twomey and Taylor, 1985), we demonstrated that 72% of the discs of elderly subjects

(60+) do not show the changes as illustrated in Rolander Grade 3 and that discs dessication and thinning is by no means universal in old age. The common clinical misconception arises as a result of the biased sample which comes to most clinicians involved in the treatment of low back pain, and by an inaccurate assessment of radiographic evidence (Twomey and Taylor, 1987).

The incidence of disc degeneration does increase in old age, and it is the lower two lumbar levels which are most often affected. These are the levels which are subject to the greatest physical stress. Fissuring of the anulus is seen with increasing frequency in old age. Initially, this is most often evident as one or two small central fissures close to the nucleus pulposus, which probably arise due to mechanical stress (Kraemer, 1982). Repeated trauma (which may include an element of sustained compression, e.g. in flexion) eventually may result in circumferential fissures in the middle and sometimes the outer layers of anulus (Figure 4). However, repetition of high velocity forces, particularly in association with torsional loads, is likely to eventually result in radial tears through the anulus, most often in the postero-lateral regions of the disc (Adams and Hutton, 1986), as in Figure 5. Since it is only the outer few lamellae of the lumbar discs which receive a nerve supply, the only fissures which might result in pain from a disc are those which extend into that region (Bogduk and Twomey, 1987).

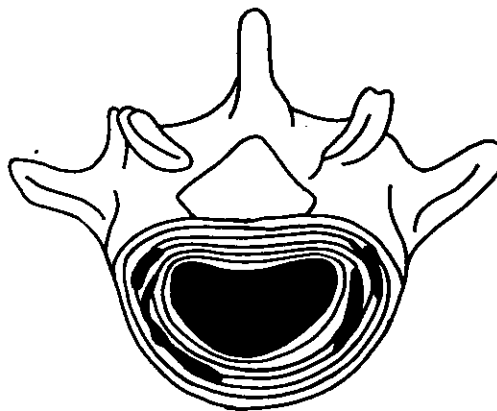


Figure 4. Diagrammatic representation of circumferential fissures in the anulus fibrosus of a lumbar intervertebral disc.

Disc fissures also provide a track for nuclear protrusion under circumstances which might allow for it. After the third decade of life, the nucleus is not fluid enough to be expressed through an anular fissure under most normal circumstances. Thus, nuclear protrusion through an anular defect can only occur in young discs, or in older discs where the nucleus undergoes autolysis and relative liquefaction. The rationale for this to occur probably involves prior fracture of the vertebral end-plate, directly exposing the avascular nucleus to the blood in the

vertebral body. Since the circulating blood has not previously been exposed directly to nuclear protein, it reacts to it as to a foreign body and sets up an auto-immune response. Autolysis and liquefaction of the nucleus follows. This is described in detail in Bogduk and Twomey (1987, p.141). Once fluid, the nucleus then has the capacity to be extended through a radial tear or tears in the anulus and perhaps gain access to the spinal canal, intervertebral canal region.

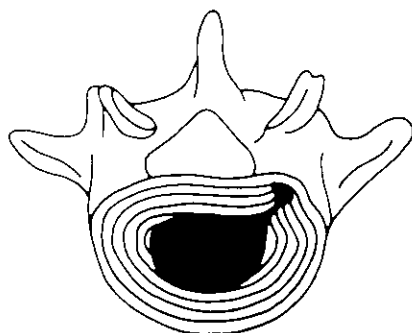


Figure 5. Diagrammatic representation of a radial fissure in the anulus fibrosus of a lumbar intervertebral disc.

Disc Mechanics:

The ranges of motions possible at any lumbar level depends on disc thickness, end-plate length and the orientation of the facets of the zygapophyseal (Z) joints (Twomey and Taylor, 1986). Given that the orientation of the Z joints is the same, individuals with relatively thick discs and short end-plates have the morphological potential for a large range of motion. This is precisely the situation noted in adolescent females, where the lumbar disc height is similar to that of adolescent males, but end-plate length is considerably shorter (Twomey, 1981), and is an important factor in explaining the greater flexibility of young females (Twomey and Taylor, 1986).

Lumbar Z joint tropism where the inclination of the paired Z joints is markedly asymmetric, provides the appropriate circumstances for a modification of potential ranges of movements, and exposes the disc at that level to substantial torsional strain (Farfan, 1973). Under these circumstances, the potential for disc damage and eventual degeneration is considerable. This again reinforces the interdependence of the joints of the articular triad at any spinal level. Damage to one element of the triad necessarily results in a disturbance of balance between the elements and eventually damages the other elements (Taylor and Twomey, 1986).

Sustained Loading:

Sustained loading to the lumbar spine results in creep of the intervertebral discs and other soft structures, until the internal tension within the structures matches the external load (Kazarian, 1975; Twomey and Taylor, 1983). Discs adjust to sustained loading by the expression of fluid (Virgin, 1951). Load removal allows the discs to

return slowly to their original shape by the imbibition of fluid by the hydrophilic proteoglycans. The lumbar spine is subject to both axial creep and creep in flexion as a routine part of many of the activities of daily living.

1. Axial Creep: This results in the loss of height which occurs through the day, mainly due to the vertical loading effect of body weight on the intervertebral discs. Most of this diurnal loss of stature is regained after about five hours of rest in the extended position, although rest in the flexed foetal position produces more rapid increases in disc height than other positions (Tyrell, Reilly and Troup, 1985). The process of axial creep forces the lumbar spine into a more lordotic posture.

2. Flexion Creep follows sustained loading of the spine in full flexion. This posture forces fluid out of the discs and other soft tissues under load, and further redistributes the remaining fluid within them. Creep in flexion is noted as the progressive increase in range, so that the end-point of the movement is increased beyond "normal" range. Discs from older subjects creep considerably more than discs from younger people. If this process is prolonged, the extrusion of fluid from the disc deprives it of most of its nutrition (Adams and Hutton, 1985). Discs and other cartilaginous/collagenous structures **require** movement to allow for the circulation of nutrient fluid within them, and lack of movement and compression loading have been shown to be potent factors in degenerative change (Salter and Field, 1960; Trias, 1961, Gamble et al, 1984). Furthermore, if the fully flexed position is sustained under load for a sufficiently long period, then the natural 'crimp' in the collagen fibrils will be progressively reduced as the fibrils elongate under the constant pressure (Shah et al, 1977).

Should the high loads be applied for long periods (as they often are under some working conditions, e.g. shearing or bricklaying), then the amount of creep which occurs is considerable and recovery back to the original starting position is extremely slow, particularly in older people. It takes many hours under rest conditions, with the spine "unloaded", for the discs to re-absorb sufficient fluid for them to return to their original size and shape.

Thus, sustained postures, particularly at the limit of flexion, are potentially dangerous for lumbar discs because of the interference with nutrition, the tension generated in stretched collagen and the time necessary for recovery once load is removed. The habitual use of fully flexed postures under sustained load is strongly implicated in disc degeneration (Twomey and Taylor, 1987). Conversely, lumbar movements in the sagittal plane have the greatest effect on the movement of fluid into and out of the intervertebral discs and, consequently, sagittal movement is a most important tool in the

maintenance of disc health and the management of postural pain problems. It seems reasonable that the use of sagittal movements and postures with an emphasis on the extension part of the range is extremely important, as most habitual working postures at the extreme of

References:

- Adams MA, Hutton WC. 1986. "The Effect of Posture on Diffusion into Lumbar Intervertebral Discs", *Journal of Anatomy*; 147:121-134.
- Armstrong JR. 1967. *Lumbar Disc Lesions*, 3rd ed., ES Livingstone, Edinburgh & London.
- Bogduk N, Twomey LT. 1987. *Clinical Anatomy of the Lumbar Spine*, Churchill Livingstone, Melbourne.
- Ericksen MF. 1974. "Aging Changes in the Shape of Human Lumbar Vertebrae". *American Journal of Physical Anthropology*; 41:477.
- Ericksen MF. 1975. "Some Aspects of Aging in the Lumbar Spine". *American Journal of Physical Anthropology*; 45:575-580.
- Farfan HF. 1973. *Mechanical Disorders of the Low Back*. Lea and Febiger, Philadelphia.
- Gamble JG, Edwards CC, Max SR. 1984. "Enzymatic adaptation in ligaments during immobilisation". *American Journal of Sports Medicine*; 12:3, 221-228.
- Kazarian L. 1975. "Creep Characteristics of the Human Spinal Column". *Orthopaedic Clinics of North America*; 6 (1):3-15.
- Kramer J. 1981. *Intervertebral Disc Lesions - Causes, Diagnosis, Treatment and Prophylaxis*. Georg Thieme Verlag, Stuttgart.
- Nachemson AL, Schultz AB, Berkson MH. 1979. "Mechanical Properties of Human Lumbar Spine Motion Segments". *Spine*; 4:1,1-8.
- Rolander SD. 1966. "Motion of the Lumbar Spine with Special Reference to the Stabilising Effect of Posterior Fusion". *Acta Orthopaedica Scandinavica*. Supplement No. 90.
- Salter RB, Field P. 1960. "The Effects of Continuous Compression on Living Articular Cartilage". *Journal of Bone and Joint Surgery*; 42A,1:31-49.
- range in Western societies are into flexion. After circumstances of prolonged standing where axial and extension creep are major factors, an emphasis on the flexion aspect of sagittal range would appear to be desirable (Twomey and Taylor, 1986).
- Schmorl G, Junghanns H. 1971. *The Human Spine in Health and Disease*. (2nd Ed.) Grune and Stratton, New York and London.
- Shah JS, Jayson MI, Hampson WG. 1977. "Low Tension Studies of Collagen Fibres from Ligaments of the Human Spine". *Annals of Rheumatic Diseases*; 36:139-148.
- Stenhouse NS. 1972. *Busselton Norms*. University of W.A. Press.
- Taylor JR, Twomey LT. 1986. "Age Changes in Lumbar Zygapophyseal Joints. Observations on Structure and Function". *Spine*; 11:7, 739-745.
- Trias A. 1961. "Effect of Persistent Pressure on the Articular Cartilage". *Journal of Bone & Joint Surgery*; 43B;2, 376-386.
- Twomey LT. 1981. "Age Changes in the Human Lumbar Spine", PhD Thesis, University of Western Australia.
- Twomey LT, Taylor JR. 1982. "Flexion Creep Deformation and Hysteresis in the Lumbar Vertebral Column". *Spine*; 7:(2), 116-122.
- Twomey LT, Taylor JR, Furniss B. 1983. "Age Changes in the Bone Density and Structure of the Lumbar Vertebral Column", *Journal of Anatomy*; 136:1, 15-25.
- Twomey LT, Taylor JR. 1985. "Age Changes in the Lumbar Intervertebral Discs", *Acta Orthopaedica Scandinavica*; 56:496-499.
- Twomey LT, Taylor JR. 1986. "Factors Influencing Range of Movement in the Lumbar Spine", *Manual Therapy*, Grieve G (ed.). Edinburgh, Churchill Livingstone, 112-120.
- Twomey LT, Taylor JR. 1987. *Physical Therapy of the Low Back*, New York, Churchill Livingstone.
- Tyrrell AR, Reilly T, Troup JDG. 1985. "Circadian Variation in Stature and the Effects of Spinal Loading", *Spine*; 10:2, 161-164.

THE ROLE OF MECHANICAL AND GENETIC FACTORS IN DEGENERATION OF THE DISC

by

Peter Ghosh

Director, Raymond Purves Research Laboratories,
and

Associate Professor, University of Sydney

Abstract

The extracellular matrix of the intervertebral disc while primarily performing a mechanical function supports and protects the cells which reside within these tissues. However, the integrity of this matrix is also totally dependent on the capacity of the cells to monitor and respond to changes in their environment.

In scoliosis (lateral curvature of the spine) excessive compressive loading is imposed on one side of the intervertebral disc. The disc cells of the annulus fibrosus respond by synthesizing an extracellular matrix which is more suitable for absorbing these stresses, i.e. a matrix which is more cartilagenous. Immobilisation of the disc by spinal fusion restricts movement which has been shown to be important for nutrition of disc cells. A study of discs of dogs showed that the chondrodystrophoid breeds (Beagle, Dachshund) responded differently to immobilisation than discs of the non-chondrodystrophoid breeds (Greyhound, Labrador).

The discs of these canine breeds are different, largely in terms of the rate at which notochordal cells present within the nucleus pulposus are replaced by chondrocyte cells. As this metamorphosis is under genetic control it was assumed that the response of disc tissues to alterations in their physical environment may also be influenced by genetic factors.

Introduction

Numerous investigations have been undertaken to determine the possible role of abnormal physical forces on the degeneration of the disc. It is not the purpose of this short review to discuss these all here, but rather summarise some recent developments in the field.

Scoliosis, or lateral curvature of the spine, provide a useful system to examine how discs might react to an altered mechanical environment. Pedrini et al (1973) attributed the significant changes observed in the glycosaminoglycans (GAGs) of discs removed from scoliotic patients to abnormal compression caused by the spinal curvature. In this study, a 25% reduction in the GAGs from the NP region in adolescent scoliotic patients and a 75% reduction in GAG levels in one case of juvenile scoliosis were reported. In all the scoliotic discs examined, collagen content was found to be elevated relative to normal controls. In the study of Pedrini et al (1983) no distinction was made between the various disc regions, e.g. lateral, anterior or posterior which because of the spinal curvature would be subjected to different stresses. However, in a more detailed study by Ghosh et al (1980), disc tissues isolated from the convex and concave sides of the scoliotic curve (see

Figure 1) were analysed separately and compared to both anterior/posterior regions and discs from normal subjects. This study showed marked differences in the levels and types of GAGs in the various regions of the scoliotic disc. Chondroitin sulphate (CS) was elevated in the compressed annular tissues (concave side of curve), whereas hyaluronic acid (HA) and keratan sulphate (KS) was elevated in tissues taken from the convex side of the scoliotic curve. These findings are summarised in Figure 1. The distribution of these GAGs was shown to be symmetrical across normal discs. A similar approach was used to study collagen distribution across the scoliotic disc (Bushell et al 1979). Tissue from disc regions on the concave side of the curve had lower levels of collagen than lateral zones on the convex side of the curve (see Figure 2).

The magnitude of these changes observed for both the GAGs and collagens of the scoliotic discs correlated reasonably well with the intensity of the deformity; being highest at the apex of the curve. This provided strong evidence that the biochemical changes detected resulted from a response of the disc cells to an altered mechanical environment. Furthermore, since the disc region subjected to compression (the concave side) showed

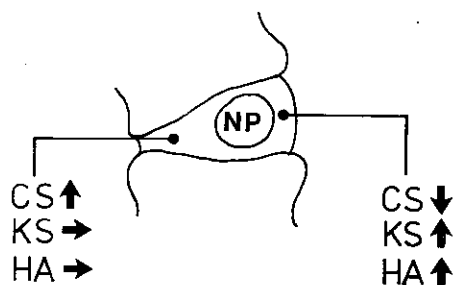


Figure 1.

Summary of GAG analysis of scoliotic discs reported by Ghosh et al (1980). Disc regions sampled from the concave side of the scoliotic curve (compression) showed increased chondroitin sulphate (CS) levels. Hyaluronic acid (HA) and keratan sulphate (KS) levels were elevated in disc regions subjected to distraction (convex side) and here the tissue was more tendon-like, i.e. higher collagen and HA content.

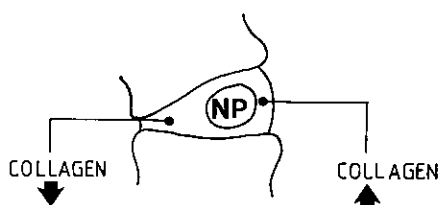


Figure 2.

Summary of collagen analysis described by Bushell et al (1979) for various regions of the scoliotic disc. In areas of compression (concave side of curve) disc collagen was less than normal, whereas the reverse was true for tissue samples taken from the convex side of the curve.

elevated CS but less collagen than normal, it was interpreted (Taylor, Ghosh and Bushell 1981) to indicate the biosynthesis by the disc cells of an extracellular matrix with more cartilagenous-like properties. Such a matrix would be more capable of withstanding compressional loading than normal annulus which is subjected to tensional stresses for the most part. Conversely, annular tissue from the convex side of the curve showed more tendon-like properties (high collagen, low CS) which is consistent with tensional loading in this segment (distraction).

The response of the disc matrix cells to immobilisation as induced by spinal fusion (arthrodesis) has been

evaluated in different breeds of dogs. The chondrodystrophoid (ChD) breeds display a high incidence of spinal disorders (Hansen 1952) which is considered to be related to premature fibrosis of the NP which was shown to be genetically determined (Ghosh et al 1975). Discs of the non-chondrodystrophoid (non-ChD) canine breeds maintain a gelatinous NP well into old age and have a low incidence of disc prolapse in the lumbar spine. Although not invariable, the chondrodystrophoid breeds generally have a high trunk to limb length ratio, (e.g. dachshund, basset hound, beagle) whereas, the non-chondrodystrophoid breeds show a ratio closer to unity (e.g. greyhound, retriever, etc.) (Figure 3). This disproportionate development of the long bones in the chondrodystrophoid breeds arises from a disturbance in the endochondral ossification process taking place in their epiphyseal cartilages during growth and maturation (Hansen 1952, Braund et al 1975).



Figure 3.

Photograph of greyhound (bottom) and beagle (top) to illustrate disproportionate ratios of trunk and limbs length. This difference in long bone growth arises from an abnormality in the endochondral ossification of epiphyseal cartilage (growth plate) in the chondrodystrophoid breeds.

Earlier experimental lumbar spinal fusion experiments conducted with immature, ChD animals (beagles) (Taylor et al 1976) showed statistically significant changes in the composition of the matrix six months post-fusion, not

only in discs encompassed by the rigid segment, but also in discs adjacent to it. The collagen level in the NP of the fusion discs was elevated, however, the GAGs were found to remain unchanged, although the galactosamine/glucosamine ratio was found to be less than in control discs. This suggested that immobilisation of the ChD canine discs, while not significantly altering the levels of PG in the disc, was influencing the structure of the PGs present. However, since immature ChD dogs were used it was uncertain whether this finding was applicable to mature animals of both canine breeds.

A study of the response to immobilisation of the canine disc of adult ChD and non-ChD breeds was therefore initiated to include a detailed examination of disc PG substructure (Cole et al 1985, 1987). Briefly, six month spinal immobilisation of the adult beagle disc induced disaggregation and loss of PGs from the discs beneath the fusion mass as well as those immediately adjacent to it. The hydrodynamic size of the PG population extracted from the fused beagle disc was found to be markedly decreased, a finding which was considered to be attributable to enhanced matrix catabolism. Moreover, after twelve months fusion, a new, larger PG population, richer in CS than control PGs, was identified suggesting an active remodelling process by the disc cells in response to their new environment (cf scoliotic discs).

In contrast to the beagle study, identical spinal fusion experiments showed that the lumbar discs of a non-ChD canine breed (greyhounds) produced a quite different response (Cole et al 1987). The concentration, extractability, extent of aggregation and the hydrodynamic size of PGs isolated from fusion and parafusion discs were elevated relative to PGs of the control discs. These results indicated a decreased, rather than increased catabolism of PGs in the greyhound disc in response to immobilisation. This finding was in agreement with the spinal immobilisation study conducted in labradors (a non-ChD breed) by Holm and Nachemson (1983), in which the discs beneath the fusion mass were found to be metabolically hypoactive. Thus, the discs encompassed by the immobilisation segment were found to show a diminished synthesis of sulphated PGs, depressed utilisation of O_2 and glucose and a higher proportion of cells in these discs were undergoing anaerobic metabolism.

Taken together, these experiments therefore clearly showed that the response of discs to immobilisation appears to be dependent on at least two major considerations: (a) the age of the subject, and (b) inherited (genetic) factors which determine the type of matrix within the discs. While (a) was to be expected (b) requires further explanation.

Two routes of solute and fluid transport have been identified in the disc - one through the cartilaginous end-

plate from blood vessels of the vertebral body, the other via the capillaries present at the periphery of the AF. In the non-ChD breeds the two routes present about the same surface area for diffusion, however, small negatively charged molecules enter via the AF while neutral molecules utilise both routes (Maroudas et al 1975, Nachemson et al 1970, Urban et al 1977, Urban and Maroudas 1980). While resting and moderate exercise had no noticeable effect on fluid transport in non-ChD dogs (Holm and Nachemson 1983, Urban et al 1982), vigorous exercise was shown to produce increased nutritional values in the more mobile discs (Holm and Nachemson 1983). This suggested that a certain range of spinal motion may provide an additional mechanism to passive diffusion for the interchange of disc metabolites with the circulation. By inference, restriction of this process by spinal immobilisation could therefore be expected to influence cell viability, particularly for those disc cells whose nutritional status was precarious.

The cells of the beagle NP are chondrocyte-like and are embedded in a dense hyalinised matrix. On the other hand, the notochordal cells of the greyhound NP are suspended in a hydrated PG rich matrix where collagen fibre density is low. As pointed out by Urban and Maroudas (1980) solute diffusion is dependent on the concentration of solids in the matrix through which the solutes must pass. Solute diffusion co-efficients in the NP of non-ChD canine discs were found to be less than in the NP of the same discs (Urban et al 1977, Urban and Maroudas 1980). It is reasonable therefore to assume that the beagle NP, which contains 2-3 times more collagen than the greyhound NP (Ghosh et al 1976), has a matrix which is more restrictive to the free movement of solute molecules than in the greyhound disc. This being the case, restriction of movement within the greyhound spine may have less profound effects on the nutrition of disc cells of this breed than cells of the beagle disc. Under restricted conditions the cells of the greyhound disc might therefore simply decrease their metabolic rate to accommodate their reduced nutritional supply. In contrast, the nutritional status of the beagle disc cells may greatly be affected when the full range of spinal flexion-extension is reduced. In response, these cells release degradative enzymes to depolymerise the extracellular matrix which is restricting their nutritional supply and could eventually lead to their demise.

The NP of man, like that of the ChD breeds commences to lose notochordal cells and deposit a hyaline-like matrix within a few years of birth (Trout et al 1982, Wolfe et al 1965). Since there is evidence in the canine that the rate at which this process takes place is genetically determined (Ghosh et al 1975) it is not illogical to hypothesise that the disc cells of man are similarly programmed. If this is so, then the response of discs within the human spine to restricted movement may, in part, be heritable. While the animal experiment

described employed surgical methods to restrict spinal movement, such procedures induced profound changes in disc metabolism within six months of application.

In the case of the human spine, disc changes arising from inadequate nutrition may occur for several reasons, e.g. maintaining bad posture (e.g. driving, flying) for long periods of time, lack of appropriate exercise, smoking, etc. These extrinsic influences coupled with an ageing disc cell population (senescence) and ill defined genetic characteristics could lead to a matrix incapable of effectively responding to the range of stresses imposed in everyday activities. The outcome must be disc failure and its sequelae of back pain or sciatica. In conclusion, it now seems clear that disc degeneration is of multifactorial aetiology of which ageing, genetic and mechanical/nutrition factors pay a prominent and inter-related role (see Figure 4).

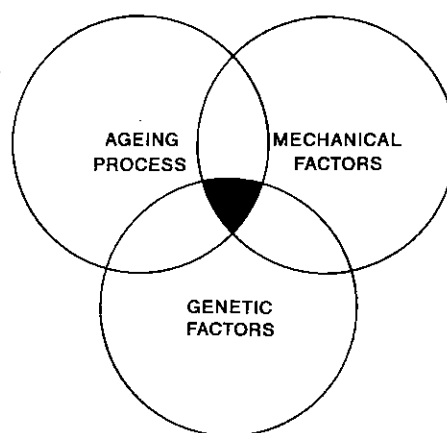


Figure 4.

Degeneration of the disc is of multifactorial aetiology, however, mechanical, ageing and genetic factors appear to play a predominant role.

References:

- Adams P, Muir H (1976). Qualitative changes with age of proteoglycans of human lumbar discs. *Annals of the Rheumatic Diseases*; 35: 289-296.
- Braund KG, Ghosh P, Taylor TKF, Larsen LH (1975). Morphological studies of the canine intervertebral disc. The assignment of the beagle to the achondroplastic classification. *Research in Veterinary Science*; 19:167-172.
- Bushell GR, Ghosh P, Taylor TKF, Sutherland JM, Braund KG (1978). The effect of spinal fusion on the collagen and proteoglycans of the canine intervertebral disc. *Journal of Surgical Research*; 25:61-69.
- Bushell GR, Ghosh P, Taylor TKF, Sutherland JM (1979). The collapse of the intervertebral disc in adolescent idiopathic scoliosis. *Journal of Bone and Joint Surgery*; 61B:501-508.
- Cole T-C, Burkhardt D, Ghosh P, Ryan M, Taylor TKF (1985). Effects of spinal fusion on the proteoglycans of the canine intervertebral disc. *Journal of Orthopaedic Research*; 3:277-291.
- Cole T-C, Ghosh P, Hannan NJ, Taylor TKF, Bellenger CR (1987). The response of the canine intervertebral disc to immobilisation produced by spinal arthrodesis is dependent on constitutional factors. *Journal of Orthopaedic Research*; 5:337-347.
- Ghosh P, Bushell GR, Taylor TKF, Pearce RH, Grimmer BJ (1980). Distribution of glycosaminoglycans across the normal and scoliotic disc. *Spine*; 5:310-317.
- Ghosh P, Taylor TKF, Braund KG, Larsen LH (1976). A comparative chemical and histochemical study of the chondrodystrophoid and non-chondrodystrophoid canine intervertebral disc. *Veterinary Pathology*; 13:414-427.
- Ghosh P, Taylor TKF, Braund KG (1977). Variation of the glycosaminoglycans of the canine intervertebral disc with ageing I. Chondrodystrophoid breed. *Gerontology*; 23:87-98.
- Ghosh P, Taylor TKF, Braund KG (1977). Variation of the glycosaminoglycans of the intervertebral disc with ageing II. Non-chondrodystrophoid breed. *Gerontology*; 23:99-109.
- Ghosh P, Taylor TKF, Braund KG, Larsen LH (1976). The collagenous and non-collagenous proteins of the canine intervertebral disc and their variation with age, spinal level and breed. *Gerontology*; 22:124-134.
- Ghosh P, Taylor TKF, Yarroll JM, Braund KG, Larsen LH (1975). Genetic factors in the maturation of the intervertebral disc. *Research in Veterinary Science*; 19:304-311.
- Hansen HJ (1952). A pathological-anatomical study on disc degeneration in dog. *Acta Orthopaedica Scandinavica Suppl. XI*, 9-117.
- Holm S, Nachemson A (1983). Variations in the nutrition of the canine intervertebral disc induced by motion. *Spine*; 8:866-874.
- Holm S, Nachemson A (1982). Nutritional changes in the canine intervertebral disc after spinal fusion. *Clinical Orthopaedics and Related Research*; 169:243-258.
- Maroudas A (1970). Distribution and diffusion of solutes in articular cartilage. *Biophysical Journal*; 10:365-379.
- Maroudas A, Stockwell RA, Nachemson A, Urban J (1975). Factors involved in the nutrition of the human lumbar intervertebral disc: Cellularity and diffusion of glucose in vitro. *Journal of Anatomy*; 120:113-130.

Maroudas A (1976). Transport of large solutes through cartilage. *Journal of Anatomy*; 122:335-3.

Nachemson A, Elfstrom G (1970). Intravital dynamic pressure measurements in lumbar disc. A study of common movements, manoeuvres and exercise. *Scandinavian Journal of Rehabilitation Medicine (Suppl. 1)*; 2:1-40.

Nachemson A (1966). The load on lumbar discs in different positions of the body. *Clinical Orthopaedics and Related Research*; 45:107-122.

Nachemson A, Lewin T, Maroudas A, Freeman MAR (1970). In-vitro diffusion of dye through the end-plates and the annulus fibrosus of human lumbar intervertebral discs. *Acta Orthopaedica Scandinavica*; 41:589-607.

Pedrin VA, Ponseti IV, Dohrman SC (1973). Glycosaminoglycans of intervertebral disc in idiopathic scoliosis. *Journal of Laboratory and Clinical Medicine*; 82:938-950.

Taylor TKF, Ghosh P, Braund KG, Sutherland JM, Sherwood AA (1976). The effect of spinal fusion on intervertebral disc composition: An experimental study. *Journal of Surgical Research*; 21:91-104.

Taylor TKF, Ghosh P, Bushell GR (1981). The contribution of the intervertebral disc to the scoliotic deformity. *Clinical*

Orthopaedics and Related Research; 156:79-90.

Trout JJ, Buckwalter JA, Moore KC, Landas SK (1982). Ultrastructure of the human intervertebral disc. I. Changes in notochordal cells with age. *Tissue and Cell*; 14:359-369.

Trout JJ, Buckwalter JA, Moore KC (1982). Ultrastructure of the human intervertebral disc. II. Cells of the nucleus pulposus. *Anatomical Record*; 204:307-314.

Urban JPG, Holm S, Maroudas A, Nachemson A (1977). Nutrition of the intervertebral disc - An in-vivo study of solute transport. *Clinical Orthopaedics and Related Research*; 129:101-114.

Urban J, Maroudas A (1980). The chemistry of the intervertebral disc in relation to its physiological function and requirements. *Clinics in Rheumatic Diseases*; 6:51-76.

Urban JPG, Holm S, Maroudas A, Nachemson A (1982). Nutrition of the intervertebral disc. Effect of fluid flow on solute transport. *Clinical Orthopaedics and Related Research*; 170:296-302.

Wolfe HJ, Putschar WGJ, Vickery AL (1965). Role of the notochord in human intervertebral disc: I. Foetus and infant. *Clinical Orthopaedics and Related Research*; 39:205-218.

VOLTAREN® ABRIDGED PRESCRIBING INFORMATION

VOLTAREN. Diclofenac Sodium. Diclofenac sodium, as a non-steroid compound, exhibits marked antirheumatic, anti-inflammatory, analgesic and antipyretic activity.

INDICATIONS: Inflammatory and Degenerative Forms of Rheumatism: Rheumatoid arthritis and osteoarthritis.

CONTRA-INDICATIONS: Hypersensitivity to diclofenac sodium. Peptic ulcer, gastro-intestinal bleeding.

Cross-sensitivity has been demonstrated between diclofenac sodium and aspirin. Therefore, VOLTAREN must not be given to patients in whom attacks of asthma, urticaria or acute rhinitis are precipitated by aspirin or by other drugs which inhibit prostaglandin synthesis.

PRECAUTIONS: Patients with a history of dyspepsia or other gastro-intestinal disorders such as Crohn's disease and ulcerative colitis or with pre-existing dysaemopoiesis or disorders of blood coagulation, as well as those with severe hepatic or renal disease, should be kept under close surveillance during treatment with VOLTAREN.

In elderly patients, who are generally more prone to side-effects, particular caution should be exercised. If peptic ulcer or gastro-intestinal bleeding occurs during treatment with VOLTAREN, administration of the drug must cease immediately.

A slight reduction in haemoglobin has been observed in some patients during long-term therapy with VOLTAREN. On rare occasions, blood dyscrasias have been reported. It is advisable to perform blood counts, at intervals, in patients receiving long-term therapy.

Use in Pregnancy: Safety of diclofenac sodium in pregnancy has not been established; therefore VOLTAREN should not be used in pregnant women or those likely to become pregnant unless the expected benefits outweigh any potential risk.

Use in Lactation: Following oral administration of VOLTAREN to six lactating women, in doses of 50 mg twice daily for the first week after parturition, no unchanged drug could be identified in the milk. The detection limit was 10 ng/ml.

Interactions with Other Drugs: Concurrent treatment with acetylsalicylic acid lowers the plasma concentration of VOLTAREN by about one-third, but the clinical significance of this effect has not been determined. The concomitant administration of VOLTAREN with preparations containing lithium or digoxin, may raise the plasma concentrations of these drugs, however, no clinical signs of overdosage in such cases have yet been encountered.

The addition of glucocorticoids to non-steroidal anti-inflammatory agents, though sometimes necessary for therapeutic reasons, may aggravate gastrointestinal side effects. The concurrent oral treatment with two or more non-steroidal antirheumatic drugs may promote the occurrence of side effects.

ADVERSE REACTIONS: VOLTAREN is generally well tolerated. At the start of treatment, however, some patients may complain of gastro-intestinal symptoms (e.g. eructation, nausea, epigastric pain or diarrhoea). These effects are usually mild and transient, and need not interfere with continuation of medication. Peptic ulcer or gastro-intestinal haemorrhage, has been reported during therapy with VOLTAREN. Usually these episodes occurred in patients with a history of such disorders, or who were receiving concomitant therapy with other drugs.

Occasionally skin reactions such as drug rash and eczema, peripheral oedema or slightly raised serum transaminase levels have been observed. There have been isolated reports of anaphylactoid reactions. Central nervous system reactions in the form of headache and dizziness, tiredness, insomnia, or irritability may be experienced by some patients, but these are usually mild and transient. The occurrence of myoclonic cephalopathy has been described in two patients.

Blood dyscrasias (aplastic anaemia, agranulocytosis, leucopenia) have been encountered very rarely in association with the use of VOLTAREN.

A few cases of haemolytic anaemia, thrombocytopenia, reduction in haemoglobin levels and positive Coombs' test have also been reported. Some further unwanted effects which have rarely been observed are jaundice, hepatitis, renal failure and nephrotic syndrome. Isolated cases of erythema multiforme have been reported.

DOSAGE AND ADMINISTRATION: Initial dosage is 75 to 150 mg daily depending on the severity of the condition, given in 2 or 3 divided doses. For long-term therapy, 75 or 100 mg daily, in divided doses, is usually sufficient.

The tablets, being enteric-coated, should be swallowed whole.

PRESENTATION AND PACKS:

VOLTAREN 25. Enteric-coated tablet containing diclofenac sodium 25 mg; round, biconvex, yellow, marked "Geigy" on one side and "B2" on the other. Containers of 50.

VOLTAREN 50. Enteric-coated tablet containing diclofenac sodium 50 mg; round, biconvex, pale brown, marked "Geigy" on one side and "G1" on the other. Containers of 50.

THE FORCES ACTING ON A LUMBAR INTERVERTEBRAL JOINT

by

W C Hutton

South Australian Institute of Technology

Abstract:

Biomechanical studies have revealed how different elements of a lumbar intervertebral joint resist the different forces to which the joint is subjected in life. Forward flexion is resisted by the capsules of the zygapophyseal joints while axial rotation is resisted by bony impaction of these joints. Axial compression is largely resisted by the intervertebral discs, although the zygapophyseal joints play a role in certain postures. The disc is protected from shear forces by the zygapophyseal joints and the action of the extensor muscles, but is denied this protection when the pars interarticularis is fractured.

Introduction:

The intervertebral joints of the lumbar spine are formed by an intervertebral disc and the zygapophyseal joints of the neural arch. The disc and the neural arch, through the zygapophyseal joints, act in concert to resist the force acting across the intervertebral joint. This force can be resolved into two components, one acting perpendicular to the disc to produce compression, and one acting in the plane of the disc to produce shear.

When the intervertebral compressive force acts anterior to the centre of rotation, forward flexion results. The reverse occurs when the compressive force acts posterior to the centre of rotation. Lateral flexion is caused by the compressive force acting lateral to the centre of rotation. Twisting (or torsion) normally occurs through muscle action offset to the centre of rotation (in the transverse plane). Thus an intervertebral joint is subjected to compression, shear, flexion and twisting. Each of these is resisted by the various components of the joint.

The way in which the lumbar intervertebral joint resists various forces applied to it has been systematically addressed in a series of studies, each of which has been reported in full in other sources (Hutton et al, 1977; Adams and Hutton, 1980, 1981; Adams et al, 1980; Dunlop et al, 1984). This paper summarises the cardinal findings of these studies.

Resistance of the Intervertebral Joint to Forward Flexion (Adams, Hutton and Stott, 1980)

Forward flexion is resisted primarily by the capsular ligaments of the zygapophyseal joints and by the intervertebral disc, with the ligamentum flavum and the supraspinous and interspinous ligaments making lesser contributions (Fig. 1). The supraspinous and interspinous ligaments are slack at small angles of flexion, but are the

first to sprain when flexion is extended too far. The whole joint acts as a stiff hinge that can, in full flexion, resist a considerable proportion of body weight.

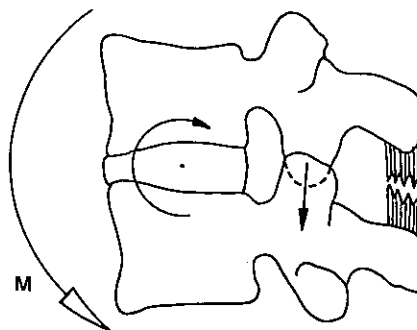


Figure 1.

Forward flexion (M) is resisted primarily by the disc and the capsular ligaments. The supraspinous and interspinous ligaments are the first to sprain when flexion is extended too far.

Resistance to Twisting Forces (Adams and Hutton, 1981)

Twisting is resisted primarily by the facet joints (Fig. 2). The normal joint can only rotate 1-2° before the articular faces, of the zygapophyseal joint in compression, come into close apposition. The disc does play a major role in twisting, but is not vulnerable to damage at such small angles; much greater angles are required to damage the disc irreversibly. This means that twisting alone is unimportant in the aetiology of disc damage, although twisting may play a part in causing disc damage, if it is combined with forward and lateral flexion.

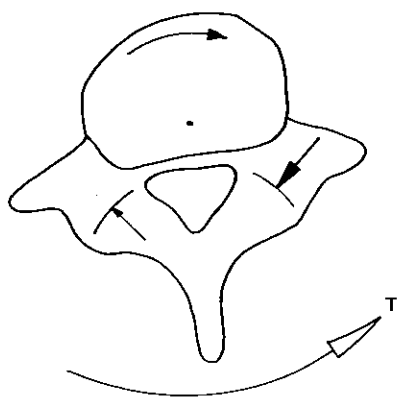


Figure 2.
Twisting (T) is resisted primarily by the facet joints.

Resistance to Intervertebral Compressive Forces (Adams and Hutton 1980; Dunlop, Adams and Hutton 1984)

Compressive forces are resisted primarily by the intervertebral disc (Fig. 3). The facets can also resist compressive forces, although this is very dependent on posture. In small angles of extension (such as standing erect) the facets resist about 16% of the compressive force between vertebrae; in slight flexion they resist none.

Disc space narrowing causes an increase in compressive force borne by the facets. This can result in high contact stresses acting across the articular cartilage. A consequence of this high stress may be pain, not from articular cartilage, but from subchondral bone or soft tissue nipped between the facets.

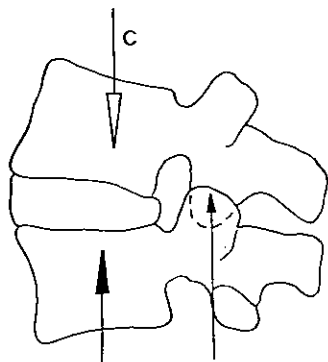


Figure 3.
Compression (C) is resisted primarily by the disc.

Resistance to Intervertebral Shear Forces (Hutton, Stott and Cyron 1977)

The disc plays a relatively minor part in resisting shear, as the extensor muscles, pulling down on the neural arch, force the zygapophyseal joints into close apposition. This bracing effect, by the extensor muscles, results in a high inter-facet force and protects the disc from shear.

When the neural arch is no longer intact (as in a pars interarticularis fracture) this "bracing" effect acts to the

detriment of the intervertebral joint; the muscles and ligaments acting on the posterior part of the neural arch pull the fractured ends of the pars interarticularis apart. The intervertebral shear force, which was effectively borne by the facet joints, now acts on the disc alone and spondylolisthesis can occur.

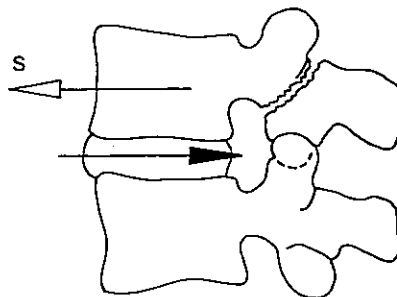


Figure 4 (a).
The shear force (S) is resisted primarily by the facet joints.

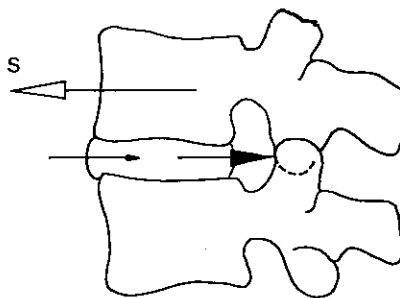


Figure 4 (b).
When the neural arch is no longer intact, the shear resistance is transferred from the facet joints to the disc.

References

- Hutton WC, Stott JRR and Cyron BM (1977). Is spondylolysis a fatigue fracture, *Spine*, 2,3 202-209.
- Adams MA, Hutton WC (1981). The effect of posture on the role of the apophyseal joints in resisting intervertebral compressive force. *Journal of Bone and Joint Surgery*, 62-B, 358-362.
- Adams MA, Hutton WC, Stott JRR (1980). The resistance to flexion of the lumbar intervertebral joint. *Spine*, 5,3, 245-253.
- Adams MA, Hutton WC (1981). The relevance of torsion to the mechanical derangement of the lumbar spine. *Spine*, 6,3, 241-248.
- Dunlop RB, Adams MA, Hutton WC (1984). Disc space narrowing and the lumbar facet joints. *The Journal of Bone and Joint Surgery*, 66-B, 706-710.

BIOMECHANICS

KUMAR S. MOMENT ARMS OF SPINAL MUSCULATURE DETERMINED FROM CT SCANS. Clinical Biomechanics 1988; 3:137-144.

Summary: Sagittal and coronal moment arm lengths of spinal extensors, flexors, and rotators were measured from the cross-sectional CT scans of 56 patients (35 males and 21 females) with no musculoskeletal disorders at 7th and 12th thoracic vertebral levels and 3rd and 5th lumbar vertebral levels. The sample had a mean age of 58.6 years (s.d. 15.5 years, range 23-90 years), mean body weight 73.15 kg (s.d. 13.9kg, range 49.5-112.8kg) and a mean body height of 169.9cm (s.d. 11.9cm, range 130-189cm). Transverso spinalis (TS), erectores spinae (ES), quadratus lumborum (QL), psoas (PS), rectus abdominis (RA), internal obliques (IO), and external obliques (EO) were measured at L3 and L5 levels. TS, ES, RA and combined obliques (CO) were measured at the T12 level; however, at T7 level only TS and ES were measured. The extensor moment arm measured (6.0cm) was significantly different from the conventional value (5.0cm). The moment arms of these muscles on the right and left sides did not differ significantly. The effect of age on the moment arm was significant only with respect to people over 60 years on the coronal plane measurements of the obliques. The gender significantly influenced the moment arms. The height, weight, and height-weight product did not regress significantly on moment arms.

Relevance: Accurate load prediction on spinal stresses by means of biomechanical models can be a valuable tool in controlling spinal injuries via task analysis and task design. All biomechanical models depend on the accuracy of the vectorial components of muscle forces for their validity. This study shows that the conventional extensor moment arm used in most biomechanical models is 20% smaller than these experimentally measured values. By providing realistic moment arm values for these as well as other muscles involved in spinal mechanics at the levels of L5 as well as T7, T12 and L3, this study can enhance the fidelity of biomechanical models.

SCHULDT K, HARMS-RINGDAHL K. CERVICAL SPINE POSITION VERSUS E.M.G. ACTIVITY IN NECK MUSCLES DURING MAXIMUM ISOMETRIC NECK EXTENSION. Clinical Biomechanics 1988; 3:129-136.

Summary: The aim of the study was to describe the relationships between cervical spine positions and neck muscle activity during maximum isometric neck extension. Ten healthy women participated (mean age 25.6 years). Maximum isometric neck extensions were performed in 12 different neck positions with resistance applied against the back of the head. Surface e.m.g. was recorded from posterior neck muscles at six locations. The e.m.g. signals were rectified, low-pass filtered and normalized. The position of the upper cervical spine did not influence the e.m.g. levels, whereas the lower cervical spine positions did. The e.m.g. levels, in the cervical erector spinae/trapezius were higher in the slightly flexed lower cervical spine position than in the neutral (despite an approximately similar magnitude of muscular moment developed), when the upper cervical spine was in the neutral position. However, when the lower cervical spine was flexed the e.m.g. level was about the same as that of the neutral lower cervical spine position (with upper cervical spine neutral). The e.m.g. levels of the splenius and the thoracic erector spinae/rhomboids varied in a similar way, but less pronouncedly. These findings are of interest for the method of normalization of e.m.g., e.g. in studies of work postures and/or movements.

Relevance: When using surface EMG as a method for evaluating the work postures and movements, normalization is often utilized and then e.m.g. changes over the range of motion — and their possible explanations — may be important.



GI TOLERABILITY. VOLTAREN PATIENTS

VOLTAREN 25
NEW NHS UNRESTRICTED BENEFIT
FROM 1ST AUGUST



NTS ARE VERY RELAXED ABOUT IT.

Gut reaction is a pretty good way to judge an anti-arthritis.

A recent re-appraisal of Voltaren re-confirms that it is associated with a low incidence of serious GI reactions.¹

The proven effectiveness^{2,3} of Voltaren helps arthritic patients get on with life. Its reassuring tolerability^{2,3} helps them enjoy it.

Voltaren®
(diclofenac sodium)

A PRESCRIPTION
FOR RELIEF

NHS Unrestricted Benefit:
50mg tablets. 50 and 3 repeats. 25mg tablets. 50 and 3 repeats.

GILBERT JA. STRESS PROTECTION OSTEOPENIA DUE TO RIGID PLATING. Clinical Biomechanics 1988; 3:179-186.

Summary: The rigid plating of bones leads to a condition of reduced bone mass under the plate. This condition, stress protection osteopenia, is of concern to clinicians because of a risk of fracture of the weakened bone after plate removal. The extent of stress protection and the consequent osteopenia is dependent on the structural rigidity of the plate in relation to the rigidity of the bone. Stress reduction of up to 50% is possible when rigid metal plates are placed on long bones. Even though numerous experimental animal studies have documented morphological changes and decreases in bone strength due to plating, more clinical studies are needed to document the extent of stress protection osteopenia in humans. The use of less rigid plates and the use of plates that become progressively less rigid with time are being explored as a means of circumventing the problem of stress protection.

RAFTOPOULOS DD, RAFKO MC, GREEN M, SCHULTZ AB. RELAXATION PHENOMENON IN LUMBAR TRUNK MUSCLES DURING LATERAL BENDING. Clinical Biomechanics 1988; 3:166-172.

Summary: This paper reports myoelectric activity measurements in the lumbar trunk muscles when subjects performed tasks involving various degrees of lateral bending. Biomechanical model analyses were made to estimate the tensions in the lumbar trunk muscles required to perform those tasks. The tensions and the activity measurements were compared to see if a muscle relaxation phenomenon occurred. A relaxation phenomenon in the erector spinae muscles was observed to occur in quiet standing in a laterally-bent position of the trunk, qualitatively similar to the flexion-relaxation phenomenon reported by Schultz et al. in 1985. However, no relaxation was observed to occur in the lateral oblique abdominal muscles in laterally-bent postures of the trunk.

Relevance: When standing in a maximum laterally-bent posture, passive mechanisms for the maintenance of equilibrium are present.

NISELL R, MIZRAHI J. KNEE AND ANKLE JOINT FORCES DURING STEPS AND JUMPS DOWN FROM TWO DIFFERENT HEIGHTS. Clinical Biomechanics 1988; 3:92-100.

Summary: Two healthy subjects were filmed on TV-video when performing 14 different steps and jumps from two different heights (0.20m and 0.43m) onto two Kistler force platforms that recorded the reaction forces. The ankle and knee load moments and joint forces were calculated using a sagittal plane semi-dynamic biomechanical model. Steps with the ball of the foot from the lower height induced a vertical ground reaction force (F_z) close to 1 body weight (bw) and around 2bw from the greater height. From the greater height the knee moments for the majority of the step-downs studied were about 100Nm, which gave knee joint compressive forces of 4-7bw. The ankle was exposed to loads of similar magnitude but not so much influenced by step height. The reasons why patients with knee pain prefer performing backward step-downs are discussed.

Relevance: This study presents a method that quantifies knee and ankle joint forces that arise during steps and jumps down. Such data are useful in rehabilitation work for assessing harmful effects of muscle and joint load at various ways of performing 'step-downs' and enable comparison of the joint load with other activities.

EKE-OKORO S. AN ELECTROMYOGRAPHIC EXAMINATION OF THE EFFECTS OF LOAD ON HUMAN GAIT. Clinical Biomechanics 1988; 3:118-120.

Summary: The electromyographic patterns of six muscles of five subjects were recorded concomitantly with surface electrodes as they walked without load (control) and when they carried a load in one hand while walking. Gait was recorded by the means of footswitches. Integrated electromyography increased with both speed and load. The e.m.g. responses of the tibialis anterior and triceps surae muscles of the same side were equal in duration and potential at all velocities. At slow and normal walking speeds, e.m.g. action durations of tibialis anterior were longer on the contralateral than on the ipsilateral side of subjects when they carried a load in one hand, while the amplitude of e.m.g. action potential was augmented on the ipsilateral in relation to the contralateral. Stance time was longer on the ipsilateral leg, while swing time was longer on the contralateral leg.

Relevance: The compensatory processes as revealed by e.m.g. and gait in the present study may help in a better

understanding of the pattern of muscle and gait adjustments needed to manage body weight in patients with one-sided weakness.

RILEY S, BADER DL. BIOMECHANICAL MEASUREMENTS OF BACK SHAPE AND INTERFACE PRESSURES IN UNSUPPORTED SITTING. Clinical Biomechanics 1988; 3:114-117.

Summary: The paper describes the use of two non-invasive techniques to provide simultaneous measurements of interface pressures and back shape in the seated posture. A modified wheelchair was used to provide adjustments of various seating parameters. The effects of varying seat angulation with four normal subjects are reported. The lumbar lordosis, evident in the standing position, was absent in the sitting position. The changing of seat base angulation affected the balance between the main areas of seating support. For example, forward inclination of the seat reduced pressures under the ischium and the posterior thigh.

Relevance: The techniques described permit a biomechanical assessment of the effects of a variety of seating parameters in the seated position. This will produce objective design criteria for seating systems, which would aim to minimise the risk of developing clinical disorders involving the lower back and the soft tissues.

STOKES IAF. MECHANICAL FUNCTION OF FACET JOINTS IN THE LUMBAR SPINE. Clinical Biomechanics 1988; 3:101-105.

Summary: Sections of human cadaver lumbar spines consisting of the L3, L4 and L5 vertebrae and the intervening discs and ligaments were tested mechanically to determine the effects of simulated spondylolysis and of facet joint fusion. Compression, flexion and extension, lateral bending, axial rotation forces and torques were applied to intact specimens and then after unilateral and bilateral division of the pars interarticularis, and, in a separate group of specimens, after unilateral and bilateral immobilisation of the facet joints.

Division of the pars interarticularis caused a large increase in axial rotation, and a lesser increase in lateral bending. Other motions were not statistically significantly changed. Facet fixation caused a statistically significant decrease in flexion and extension only. The average anterior or posterior shear motion across the intervertebral discs was less than 1mm in magnitude in intact specimens, and none of the interventions produced statistically significant changes in this motion accompanying the angular motion.

Relevance: These findings from cadaver specimens demonstrate how the motion of the lumbar spine may be affected acutely by spondylolysis fracture and by facet fusion *in vivo*. They show that a major role of intact facet joints is limitation of axial rotation motion. Probably it is the flexibility of the neural arch which permits substantial motion between vertebrae after immobilisation of facet joints.

NIGG BM, SKLERYK BN. GAIT CHARACTERISTICS OF THE ELDERLY. Clinical Biomechanics 1988;3:79-87.

Summary: The purpose of this study was to investigate the effects of aging on gait for people 60 years old and above using gait variables commonly applied in sport shoe analysis. Thirty-eight subjects were divided into age groups: 60-69 years and 70-82 years. They walked along a carpeted walkway at a comfortable walking speed wearing a pair of their own walking shoes and a pair of laboratory supplied sports shoes. Kinetic and kinematic data were collected and subsequently analysed. Subjects of the older age group (70-82 years) displayed less movement in the subtalar joint during the support phase of walking with the personal shoes than subjects of the younger age group. Subjects of the older age group walked more slowly and exerted lower anterior-posterior forces with both the personal and laboratory shoes than subjects of the younger age group. Trends suggest (not statistically significant) that foot movement during mid-stance decreases with increasing age. It is speculated that this decrease in foot movement may be due to increased stiffness in the ankle and subtalar joint with age and/or due to a selection process of the older test subjects to prefer shoes with more support. Further research is needed to support or reject these speculations.

Relevance: In light of the expected increase in the number of physically active people over 60 years of age and based on the speculation that walking may be one of their preferred exercises, it seems appropriate to document the gait characteristics of the elderly. The results of this study may be useful in the design of footwear which satisfies the gait requirements of people 60 years old and above.

SCHNEBEL BE, SIMMONS JW, CHOWNING J, DAVIDSON R. **A DIGITIZING TECHNIQUE FOR THE STUDY OF MOVEMENT OF INTRADISCAL DYE IN RESPONSE TO FLEXION AND EXTENSION OF THE LUMBAR SPINE.** Spine 1988;13:309-312.

Abstract: The effects of flexion and extension exercises on lumbar discs and low-back pain are controversial. Our goals were to develop a technique and program for digitizing and analysing discograms and to study the motion of intradiscal dye in response to flexion and extension. Thirty-five patients following awake discography were evaluated with lateral radiographs obtained in an extension position and a flexion position. Fifty-three segments with normal morphology and 47 segments with abnormal morphology were studied. Discograms with normal morphology showed numerically significant change in position with a more anterior position occurring during extension. Changes in the position of intradiscal dye in discs with abnormal morphology were less predictable. Digitizing was an advantageous technique.

CASSIDY JD, YONG-HING K, KIRKALDY-WILLIS WH, WILKINSON AA. **A STUDY OF THE EFFECTS OF BIPEDISM AND UPRIGHT POSTURE ON THE LUMBOSACRAL SPINE AND PARAVERTEBRAL MUSCLES OF THE WISTAR RAT.** Spine 1988;13:301-308.

Abstract: Twenty-one bipedal rats were prepared by forelimb amputation and reared with 19 control rats. All of the bipedal rats became proficient upright walkers. There was significant anterior wedging of the lower lumbar vertebral bodies in all of the bipedal rats and four had radiographic evidence of degenerative disc disease. Five bipedal rats developed lumbosacral disc herniations, and the lumbar neural canal was significantly smaller in the bipedal population. There was no difference in radionuclide uptake between the two groups. Histochemical analysis of the psoas and multifidus muscles showed a significant shift from type I to type II fibres in the psoas and from type II to type I fibres in the multifidus in the bipedal population. These results indicate that upright posture places considerable stress on the lumbosacral spine and paravertebral muscles of the rat.

GOEL VK, VOO L-M, WEINSTEIN JN, LIU Y KING, OKUMA T, NJUS GO. **RESPONSE OF THE LIGAMENTOUS LUMBAR SPINE TO CYCLIC BENDING LOADS.** Spine 1988;13:294-300.

Abstract: The effect of a "pure" cyclic flexion bending moment on the three-dimensional load-displacement behaviour of fresh ligamentous lumbar spine was investigated. The load-displacement behaviour, for 11 L1-sacrum specimens, pre- and post-cyclic fatigue bending tests were quantified using a Selspot II system. A special fixture was designed to mount the specimen within the MTS system to administer "pure" cyclic flexion bending, under displacement control, for 5 hours. The testing was accomplished in a 100% humidity chamber at 0.5 Hz. The maximum cyclic bending moment, based on the literature dealing with loads experienced by the spine during activities involving lifting, was set at 3.0 Nm. An increase in motion of the order of 10% in the extension loading mode was observed. The increase in motion in other loading modes was not significant. In the extension loading mode, the increase in the anteroposterior displacement (retrodisplacement) in general was higher than the corresponding rotation component. The results suggest that the bending moment of low magnitude, usually experienced by the spine during activities of daily living, alone may not trigger the mechanical failure processes in the disc. The presence of high axial compressive loads on the disc seems to be the main contributing factor in this process. The presence of bending moments and axial twist along with axial compressive load may accelerate the unstable processes leading to low back pain.

MILLER LS, COTLER HB, DE LUCIA FA, COTLER JM, HUME EL. **BIOMECHANICAL ANALYSIS OF CERVICAL DISTRACTION.** Spine 1987;12:831-837.

Abstract: A biomechanical analysis of cervical distraction is presented, and a model comparing closed reduction of cervical spine dislocations to spring mechanics is developed. Behaviour of a spring may be described as $F=k\Delta x$; where F =distraction force; Δx =elongation of the spring; and k =spring constant. The records and roentgenograms of 24 cervical spine dislocations were reviewed retrospectively. Evaluation of cervical distraction vs traction weight indicates that $F_{\text{traction}} = k_{\text{neck}} \Delta x$; where F =traction weight and x =distraction at the injured level. The constant, k_{neck} , is different for bilateral and unilateral dislocations ($P<.001$) and is a function of magnitude of injury and neck morphology. As determined in this study, traction weight needed for reduction of facet dislocations may be estimated using the formulae: $F_{\text{ix}} = 107.1 \text{ lbs/cm (x) unilateral}$, and $F_{\text{ix}} = 76.4 \text{ lbs/cm (x) bilateral}$.

Abstract: A coupling between the lateral flexion and axial rotation as a result of the geometric arrangement of the motion segments is well known in a normal spine. The kinematic behaviour of idiopathic scoliotic spines has been analysed by means of a biomechanical model study and a radiologic study. The anteroposterior and lateral flexion radiographs of 40 patients with progressive adolescent idiopathic scoliosis were studied. In five of these patients, anteroposterior radiographs were also made with the spine in a ventrally flexed position. The kinematic behaviour of a nonpathologic spine was examined by means of a three-dimensional, nonlinear geometric mathematical model of the spine. The frontal plane inclination of the facet joints in conjunction with the vertebral orientation in the sagittal plane influenced the kinematic behaviour in the normal spine. In a scoliotic spine, there is an axially rotated position and, in most cases, a dorsal inclination (lordotic) of the motion segments. Nevertheless, the direction of the axial rotation during lateral flexion does not differ from the direction of the axial rotation during lateral flexion in a normal spine. The existing axial rotation in idiopathic scoliosis cannot be explained on the basis of spinal kinematics. In contrast to normal spines, in scoliotic spines exists a coupling between ventral flexion or extension and axial rotation. This may be essential in the management of idiopathic scoliosis.

PANAGIOTACOPULOS ND, POPE MH, BLOCH R, KRAG M. **WATER CONTENT IN HUMAN INTERVERTEBRAL DISCS. Part II. Viscoelastic Behaviour.** Spine 1987;12:918-924.

Abstract: Water content of intervertebral discs is a significant aspect of both viscoelastic behaviour and age-related degenerative changes. Using water content as a dependent variable, stress-relaxation was measured using standardised annulus fibrosus specimens strained at various levels of strain. Synthesis of experimental data into a master relaxation curve allows prediction of specimen response over time intervals not readily accessible experimentally. A quantitative understanding of the role of water content may have important clinical application, since magnetic resonance imaging is a tool which should allow water content determination *in vivo*.

SCHULDT K, HARMS-RINGDAHL K. **E.M.G./MOMENT RELATIONSHIPS IN NECK MUSCLES DURING ISOMETRIC CERVICAL SPINE EXTENSION.** Clinical Biomechanics 1988;3:58-65.

Summary: The aim of the study was to describe the e.m.g./muscular moment (torque) relationships for neck and shoulder muscles during cervical spine extension. Ten healthy women participated. Their average age was 25.6 years. The neck extension muscular moments exerted were measured isometrically in neutral and in flexed lower-cervical spine positions with a strain gauge connected to a sling around the back of the head. The moment about the bilateral axis of the C₇-T₁ spinal motion segment was calculated as the moment balancing the sum of the moment of the sling resistance force and the moment caused by the gravity forces of the head and neck. Video images were analysed for moment arm length measurements. Simultaneously with the force recording, the e.m.g. activity was recorded through surface electrodes applied unilaterally at six locations in the neck and shoulder region. The rectified low-pass filtered e.m.g. signals were normalised against the highest activity level obtained during a series of standardised isometric test contractions.

The results show that a non-linear e.m.g./moment relationship exists in axial musculature of the cervical spine, with a slightly higher increase in e.m.g. levels at high muscular moment values.

Relevance: Electromyography is a method used for assessing muscular load in work tasks to evaluate ergonomic measures. Thus, it is of importance to know the e.m.g./force relationship in posterior neck muscles and its variability.

HAMZEH MA, BOWKER P, ROWLEY DI. **BELOW-KNEE CAST DESIGN AND THE ENERGY COST OF AMBULATION.** Clinical Biomechanics 1988;3:74-78.

Summary: The influence of various aspects of the design of below-knee walking casts on the energy required for ambulation has been examined using a technique based on heart rate measurements. It was found that the effects of the weight of the cast and the shape of the sole applied were small compared with the effects of changing ankle angle or of increasing the overall thickness of the cast sole.

Relevance: The results of this study provide data which can be directly applied in fracture clinics to help minimise the metabolic energy cost of walking in a below-knee cast.

TROPP H, ASKLING C. **EFFECTS OF ANKLE DISC TRAINING ON MUSCULAR STRENGTH AND POSTURAL CONTROL.** Clinical Biomechanics 1988;3:88-91.

Summary: Ankle disc training gave good objective results in patients with functional instability of the ankle joint, that is a feeling of giving way or recurrent sprains. The training programme improved both postural control, as demonstrated by stabilometry, and isokinetic pronator muscle strength. A 10-week training period was apparently sufficient, and further training could not be shown to be beneficial.

Relevance: This paper describes the beneficial effects of ankle disc training on two parameters previously found to be impaired among patients with functional instability of the ankle joint.

BURTON AK, TILLOTSON KM. **REFERENCE VALUES FOR 'NORMAL' REGIONAL LUMBAR SAGITTAL MOBILITY.** Clinical Biomechanics 1988;3:106-113.

Summary: From a sample of 958 individuals, a group with no anamnestic recall of notable low back trouble ($n=510$) was selected to provide reference values for lumbar sagittal mobility. The measurement technique employed a flexicurve to give angular measures for maximal sagittal mobility in upper (T_{12} - L_4) and lower (L_4 - S_2) regions. The results are presented in the form of reference ranges and modal values, stratified by age and sex. A wide variation in the 'normal' range of mobility at all ages is confirmed. Males had higher values for flexion, whilst females showed higher values for extension and for mobility in the lower region. Sagittal mobility declined with age at different rates in males and females for both flexion/extension and upper/lower measures. Generally speaking, mobility was reduced by some 50% in old age compared with childhood, the reduction being most marked for measures of flexion and upper lumbar mobility.

Relevance: Age- and sex-related reference values for regional lumbar sagittal mobility have been defined for a large sample without a history of back trouble, using a reliable and valid measurement method. These values will be of interest to clinicians, either directly, or for investigative studies of the relationship between sagittal mobility and back trouble. In addition, they may be used in mathematical modelling of lumbar function.

BENDIX A, JENSEN CV, BENDIX T. **POSTURE, ACCEPTABILITY AND ENERGY CONSUMPTION ON A TILTABLE AND A KNEE-SUPPORT CHAIR.** Clinical Biomechanics 1988;3:66-73.

Summary: Sitting postures on a knee-support (Balans®) chair and a tiltable chair were investigated with 12 healthy subjects during office work and simulated assembly work. After at least 3 weeks' adaptation to each chair, the subjects were investigated for 1 hour on each chair in stratified sequence. Postures were evaluated by means of a statometric method. Spinal load was further estimated by measuring stature shrinkage over each sitting period. Energy consumption was roughly assessed by pulse measurements. Finally, subjective acceptability was rated by a 5-point scale.

Posture effects of the Balans® chair, taken in relation to the tiltable chair, were primarily a forward tilt of the pelvis and a change toward lumbar lordosis. Secondly, the trunk was vertical compared to the slightly backward-inclined position in the tiltable chair. The head was most vertical in the Balans® chair. No effect on spinal shrinkage or pulse was observed. The subjective rating seemed to favour the tiltable chair if used over longer periods. However, the Balans® chair may be a good alternative for some seated periods and special tasks.

Relevance: Both Balans® and tiltable chairs have obtained widespread popularity, and both are claimed by their manufacturers to be advantageous against back pain. Very little biomechanical investigation of the Balans® chair in particular has been carried out previously; this report, in part, corrects the deficit.



TAYLOR JR, TWOMEY LT. **AGE CHANGES IN LUMBAR ZYGAPOPHYSEAL JOINTS. OBSERVATIONS ON STRUCTURE AND FUNCTION.** Spine 1986; 11:739-45.

Abstract: Transverse sections of zygapophyseal joints from 61 human, postmortem, lumbar spines of individuals ranging in age from fetal life to 84 years, were used for a study of age changes in relation to biomechanical function. The articular cartilage and subchondral bone of the anterior, coronally oriented third of the joint show changes that are likely to be related to loading of this part of the joint in flexion. The posterior, sagittally oriented two-thirds of the joint shows different age changes, which may reflect shearing forces, imparted to the articular cartilage through the fibrous capsule. The subchondral bone plate, which thickens into a wedge shape with growth to maturity, probably in response to loading stress in flexion, retains this shape into old age despite the bone loss associated with osteoporosis.

VELDHUIZEN AG, BAAS P, WEBB PJ. **OBSERVATIONS ON THE GROWTH OF THE ADOLESCENT SPINE.** J Bone Joint Surg 1986; 68-B:724-8.

Abstract: We have measured the increase in height and width of the vertebral bodies and expressed them as percentages of the total growth in children aged 10 to 17 years. The first group, 10 boys and 10 girls, each had a single thoracic adolescent idiopathic scoliosis while the second group, 10 girls, each had a single lumbar adolescent idiopathic scoliosis.

No significant differences were found between the growth increments and spinal dimensions of the vertebral bodies involved in the scoliotic curve and those vertebrae outside the curve in the same patient. The vertebrae were more slender in girls than in boys.

GILES LGF. **LUMBO-SACRAL AND CERVICAL ZYGAPOPHYSEAL JOINT INCLUSIONS.** Manual Medicine 1986; 2:89-92.

Abstract: Entrapment of intra-articular synovial folds between the facets of zygapophyseal joints has been implicated in cases of acute paraspinal muscle spasm and pain with "locking" of adjacent motion segments. However, some authors question this concept. A literature survey of zygapophyseal joint inclusion anatomy, function, and pathological changes is summarised. The results of a histological survey of adult lumbo-sacral and cervical zygapophyseal joint inclusions is described. It is concluded that entrapped zygapophyseal joint inclusions may well give rise to acute reflex paraspinal muscle spasm and pain. Therefore, it is likely that spinal manipulation will give relief in cases of acute low back pain and torticollis when these conditions are due to entrapment of intra-articular synovial inclusions.

DEANS GT, MAGALLIARD JN, KERR M, RUTHERFORD WH. **NECK SPRAIN - A MAJOR CAUSE OF DISABILITY FOLLOWING CAR ACCIDENTS.** Injury 1987; 18:10-12.

Abstract: One hundred and thirty-seven patients attending hospital following road traffic accidents were contacted regarding pain in the neck between 1 and 2 years later. Eighty-five (62 per cent) stated that they had suffered pain in the neck at some time following their accident compared with 42 (30.6 per cent) who were noted to have pain in the neck when examined soon after the accident. Thirty-one patients (22.6 per cent) still felt occasional pain 1 year after the accident and 5 had continuous pain at 1 year. Pain in the neck occurred irrespective of the direction of impact but was disproportionately common in rear impact accidents. Patients wearing seat belts experienced pain more frequently than unbelted patients.

ASCANI E, BARTOLOZZI R, LOGROSCINO CA, MARCHETTI PG, PONTE A, SAVINI R, TRAVAGLINI F, BINAZZI R, DI SILVESTRE M. **NATURAL HISTORY OF UNTREATED IDIOPATHIC SCOLIOSIS AFTER SKELETAL MATURITY.** Spine 1986; 11:784-9.

Abstract: A total of 187 random cases of untreated idiopathic scoliosis, seen from a minimum of 15 to a maximum of 47 years after the end of growth, were reviewed. All curves increased after skeletal maturity (average progression:

0.4° per year). Thoracic curves tend to progress more than lumbar, lumbar more than thoracolumbar, and thoracolumbar more than double major curves. Pain was present in 114 cases (61%) and appeared more frequently in women, after pregnancies, and with fatigue. Cardiopulmonary symptoms were present in 42 patients (22%), especially those with thoracic and thoracolumbar curves greater than 40°. Psychologic disturbances were found in 35 cases (19%), mostly female patients with thoracic curves greater than 40°. The cosmetic appearance of these patients at long-term follow-up was better compared with that at the end of growth even though the curves progressed. Patients with decompensation of the trunk at the end of growth seemed to improve with time. In an unselected group of patients with severe curves a mortality rate of 17% was found, twice as much as the Italian general population.

ARKUSZEWSKI Z. INVOLVEMENT OF THE CERVICAL SPINE IN BACK PAIN. Manual Medicine 1986; 2:126-8.

Abstract: A total of 100 patients with lumbago or sciatica were allocated alternately to two groups; all received standard drug treatment and physiotherapy and underwent manual examination twice a week. In the manual treatment group, after each examination traction, mobilisation and/or manipulation were applied to all parts of the spine with functional movement restriction and soft tissue reflex changes. In 60% of patients there was concomitant neck pain. Blockages of the cervical segments were found in 95% of patients, the atlanto-occipital segment being the one most frequently affected. In the manual treatment group the treatment period was shorter, and posture, intensity of pain and neurological signs showed greater improvement both on discharge and 6 months later. Patients with concomitant neck pain experienced more pronounced improvement of their neurological symptoms, but those without neck pain had better posture after manual treatment.

KOSTUIK JP, HARRINGTON I, ALEXANDER D, RAND W, EVANS D. CAUDA EQUINA SYNDROME AND LUMBAR DISC HERNIATION. J Bone Joint Surg 1986; 68-A:386-91.

Abstract: In a retrospective chart review of the cases of 31 patients with cauda equina syndrome secondary to a central disc lesion, we identified two modes of presentation. The first was an acute mode (ten patients) in which there were abrupt, more severe symptoms and signs and a slightly poorer prognosis after decompression, especially for the return of bladder function. The second mode of presentation (21 patients) was a slower onset, characterised by prior symptoms for varying time-intervals before the more gradual onset of the cauda equina syndrome. All patients had urinary retention preoperatively. Bladder function was the most seriously affected function preoperatively and remained so postoperatively. The prognosis for return of motor function was good, since 27 of the 30 patients who were operated on regained normal motor function. Preoperatively, all patients had sciatica, which was bilateral in 14 and unilateral in 17. The average time to surgical decompression after the patient was seen ranged from 1.1 days for the more acute lesions to 3.3 days for the second group. There was no correlation of these times with return of function. Therefore, even though early surgery is recommended, decompression does not have to be performed in less than 6 hours if recovery is to occur, as has been suggested in the past.

PECK D, NICHOLLS PJ, BEARD C, ALLEN JR. ARE THERE COMPARTMENT SYNDROMES IN SOME PATIENTS WITH IDIOPATHIC BACK PAIN? Spine 1986; 11:468-75.

Abstract: Palpable rigidity of the epaxial (paraspinal) muscles, lordotic flattening, and spinal flexion accompanying back pain generally are ascribed to epaxial muscle spasm. However, palpable rigidity without muscle spasm occurs in compartment syndromes and epaxial muscle contractions extend to the spine, increasing lordosis. Epaxial compartment syndromes are proposed as a possible cause of palpable rigidity, lordotic flattening, and spinal flexion accompanying idiopathic back pain. This article demonstrates the following: existence of an epaxial compartment by latex and dye injections; simulation of epaxial compartment syndromes in unembalmed cadavers by saline injections; and a "Bourdon tube effect" producing spinal flexion with lordotic flattening during epaxial compartment syndrome simulation in embalmed cadavers. In addition, resting and exercising epaxial compartment pressures were measured in 18 normal volunteers with a slit catheter.

MORRIS EW, DI PAOLA M, VALLANCE R, WADDELL G. **DIAGNOSIS AND DECISION MAKING IN LUMBAR DISC PROLAPSE AND NERVE ENTRAPMENT.** Spine 1986; 11:436-9.

Abstract: This prospective study of 185 patients undergoing first-time lumbar surgery compared how accurately clinical criteria and water-soluble myelography predicted the operative findings. Clinical diagnostic criteria of nerve root pain, root irritation signs, and neurologic signs of root compression supplemented by myelography were shown to be much more accurate than myelography alone, both in predicting the presence or absence of nerve root involvement and in distinguishing disc prolapse from bony entrapment. Provided the clinical criteria were clearly defined, patients with three or more of the four criteria were usually found to have a disc prolapse while bony entrapment could frequently be identified with one or two criteria. It is concluded that although lumbar disc prolapse is well-recognised, in practice clinical assessment and diagnostic criteria need to be defined more clearly to match increasingly sophisticated radiology.

HELIOVAARA M, VANHARANTA H, KORPI J, TROUP JDG. **HERNIATED LUMBAR DISC SYNDROME AND VERTEBRAL CANALS.** Spine 1986; 11:433-5.

Abstract: Herniated lumbar disc or definite sciatica was diagnosed in 16 of 195 men and women who had reported a history of low-back pain in a health survey. Measurements related to the size and shape of the lumbar spinal canal were subsequently made from the survey radiographs and compared between various types of back syndromes. Age, body height, body mass index, occupation, and parity of women were controlled as potential confounders using analysis of covariance. Several dimensions of lumbar vertebral canals appeared more shallow in the subjects who had herniated disc or definite sciatica than in the other ones. In particular, the interarticular distance of the first sacral vertebra was found to be narrowed in the presence of sciatica, the difference of the adjusted distances to the other back pain category being in men 30.5 mm versus 35.1 mm ($P=0.02$) and in women 23.8 mm versus 30.3 mm ($P=0.002$), respectively.

EDELSON JG, NATHAN H. **NERVE ROOT COMPRESSION IN SPONDYLOLYSIS AND SPONDYLOLISTHESIS.** J Bone Joint Surg 1986; 68B:596-9.

Abstract: Thirty-four bony specimens of isthmic spondylolysis were examined and, in a significant number (32%) stenosis of the intervertebral foramen was noted. Although not emphasised in previous reports, this finding may be an important factor in the aetiology of nerve root compression when this is associated with spondylolysis and spondylolisthesis. Anatomical guidelines for adequate surgical decompression are suggested.

WEATHERELL VF. **COMPARISON OF ELECTROMYOGRAPHIC ACTIVITY IN NORMAL LUMBAR SACROSPINALIS MUSCULATURE DURING STATIC PELVIC TRACTION IN TWO DIFFERENT POSITIONS.** J Orthop Sports Phys Med 1987; 8:382-90.

Abstract: The purpose of this study was to determine if there is any significant difference in electromyographic activity in normal lumbar sacrospinalis musculature during static pelvic traction between the supine and prone positions. Electromyographic activity was monitored on 17 normal participants. Each participant received static pelvic traction in prone and in supine for 15 minutes. The analysis of variance for the repeated measures design found significantly less lumbar sacrospinalis muscle activity during traction in the prone position than during traction in the supine position ($p<0.05$). An analysis of covariance determined that the difference between muscle activity during traction in the prone and supine positions was not significantly affected by differences in sex, age, height, weight, treatment order, time of treatment, electrical noise levels prior to treatment, and electrical noise levels after treatment. Implications for treatment are discussed.

POUNTAIN GD, KEEGAN AL, JAYSON MIV. **IMPAIRED FIBRINOLYTIC ACTIVITY IN DEFINED CHRONIC BACK PAIN SYNDROMES.** Spine 1987; 12:83-6.

Abstract: Fibrinolytic activity was studied in 34 patients who had chronic low-back pain of defined types (spondylosis, postlaminectomy and postmyelography-proven arachnoiditis, postlaminectomy and postmyelography-possible arachnoiditis, chronic prolapsed intervertebral disc (PID), spinal stenosis, and nonspecific low-back pain). Fibrinolysis was significantly impaired in the back pain patients as a whole compared with matched controls. Similar changes were

observed in all the different back pain syndromes. In the smaller subgroups, these did not reach significance but were significant in spondylosis, proven arachnoiditis, and nonspecific back pain. It is suggested that the abnormal persistence of a defect in fibrinolytic activity, leading to fibrin deposition and chronic inflammation, may be an important factor in the chronicity of many back pain syndromes.

HOSEA TM, SIMON SR, DELATIZKY J, WONG MA, HSIEH CC. MYOELECTRIC ANALYSIS OF THE PARASPINAL MUSCULATURE IN RELATION TO AUTOMOBILE DRIVING. Spine 1986; 11: 928-36

Abstract: In this study, the myoelectric activity of 12 paraspinal muscles of ten men aged 18-24 was recorded to examine the effects of backrest inclination and lumbar support in relation to driving. In total, 24 test conditions were evaluated over a 3 - 5 hour period in a single day. These tests were then repeated, changing the sequence over the next 4 days. The results indicate a complex interaction between the thoracic and lumbar regions of the back with the lowest myoelectric activity position of 120° backrest inclination, 5cm of lumbar support, and 13.5-18.5° of seat inclination.

Electromyogramatic (EMG) evidence of fatigue was not identified over a 3.5 hour period. The generally low levels of EMG activity and, presumably, disc pressure present in any seating position suggest that the paraspinal muscle activity may not play the predominant role in disc herniation as it relates to automobile driving.

BOGDUK N, JULL G. THE THEORETICAL PATHOLOGY OF ACUTE LOCKED BACK. A basis for manipulative therapy. Manuelle Medizin 1985; 23: 77-81.

Abstract: As an explanation for the pathological basis for acute locked back, meniscus entrapment is a concept that is inconsistent with both the anatomy of zygapophysial menisci and the clinical features of acute locked back. Two alternative explanations that better fit the clinical features are postulated: meniscus extrapment and intradiscal nuclear displacement, both of which are amenable to manipulative therapy.

Fitzer PM. ANTERIOR HERNIATION OF THE NUCLEUS PULPOSUS: RADIOLOGIC AND CLINICAL FEATURES. South Med J 1985; 78: 1296-1300.

Abstract: A prospective study disclosed eight patients (three children and five adults) with anterior herniation of the nucleus pulposus (AHNP); in five of the eight, AHNP was an incidental finding. Radiological findings included erosion and/or fracture of the anterior aspect of the vertebra, usually with interspace narrowing. The complete blood count and erythrocyte sedimentation rate were normal in children with AHNP. A 5-yr clinical follow-up of six of the eight patients showed minimal morbidity in five; one patient had surgery with good results. AHNP is usually confused with fracture (old or acute) or infection; the correct radiological diagnosis obviates the need for invasive diagnostic tests. Computerized tomography and nuclear magnetic resonance may prove to be useful in the diagnosis of AHNP.

PARKE WW, WATANBER. THE INTRINSIC VASCULATURE OF THE LUMBOSACRAL SPINAL NERVE ROOTS. Spine 1985; 10: 508-15.

Abstract: The observations made in this study strongly support the concept that spinal nerve roots in general and the human lumbosacral spinal nerve roots in particular are structurally, vascularly and metabolically unique regions of the nervous system. Peculiarities of their intrinsic vasculature and supporting connective tissue may account for suspected "neuroischemic" responses to pathological mechanical stresses and inflammatory conditions associated with degenerative disease of the lower spine. It is hoped that the newly described features of the radicular vasa nervorum (to avoid confusion with the dissimilar blood supply of peripheral nerves, the term "vasa radicularum" might be more accurate) may advance the understanding of certain aspects of lower spine symptomatology and provide some basis for much needed future research.

Abstract: This study is a retrospective review of 221 patients with untreated idiopathic thoracic and thoracolumbar scoliosis that were observed from the first months of life until maturity. There are three stages in the evolution of these curves: a single main period of progression, a secondary period of progression, and a stable period. The chronology of these different periods varies. In "infantile scoliosis," the main period of accelerated increase of the curve occurs prior to 6 years of age. In "juvenile-puberal scoliosis," it occurs from 6 years of age to the first stages of puberty, and in "puberal scoliosis," the main increase occurs during puberty or adolescence. The prognosis of the scoliosis can be established at any age based on different parameters, such as the specific angle of rotation from birth to 6 years of age, the torsion angle from 6 years of age to P2, and the Cobb angle after puberty.

REGENBOGEN VS, ROGERS LF, ATLAS SW, KIM KS. **CERVICAL SPINAL CORD INJURIES IN PATIENTS WITH CERVICAL SPONDYLOSIS.** AJR 1986; 146: 277-84.

Abstract: Eighty-eight patients over age 40 with traumatic cervical spinal cord injuries were clinically and radiographically evaluated, and comparison was made with 35 spinal cord injury patients under age 36. While most older patients sustained obvious bony and/or ligamentous damage commensurate with their neurologic findings, 25 (28%) of the 88 patients had no demonstrable bony abnormalities and 17 (20%) of the 88 patients had only minimal evidence of bony injury. Of particular interest are the patients with severe cord injuries, yet no bony abnormalities, who seem to form a distinct subgroup of the cervical spinal cord injury patient on the basis of radiographic and clinical features. Of these 25 patients, 24 (96%) had severe cervical spondylosis. Fourteen (56%) of the 25 patients were injured in falls, five (36%) of these 14 being of a seemingly trivial nature. Of the 42 patients with minimal or no demonstrable bony abnormalities, 33 (79%) were evaluated with plain tomography and no occult fractures or other significant pathology was demonstrated. Pantopaque myelography in 27 (64%) of the 42 cases revealed no extruded disc or other surgical lesion in any patient. In large measure, these injuries can be attributed to cervical spondylosis, which narrows the canal and makes the cord more susceptible to compression by the bulging ligamenta flava during hyperextension.

WHIELDON TJ. **SACROILIAC DYSFUNCTION IN RUNNERS.** Athletic Training 1986; 21: 15-9

Abstract: Anatomists have classified the sacroiliac articulation as a diarthrosis or synovial joint. The synovial characteristics include a joint cavity containing synovial fluid, cartilage covering the bony surfaces, a joint capsule consisting of an outer fibrous layer and an inner synovial membrane, ligaments connecting the bones, and articular connections allowing movement between bone surfaces.

During normal running gait, posterior ilium rotation occurs with heel strike. The ilium rotates anteriorly from mid-stance phase to toe-off and remains rotated until heel strike occurs again on the same side. The opposite ilium rotates reciprocally.

Abnormal running mechanics result in abnormal pelvic rotation. This abnormal rotation may cause an ilium to wedge and lock on the sacrum, resulting in sacroiliac dysfunction and pain.

Evaluation techniques allow differentiation between lumbar discogenic problems, lumbar facet irritation, and sacroiliac dysfunction. Specific techniques determine abnormal ilium rotation.

A muscular contraction technique is described which has reduced or alleviated complaints of unilateral hip and low back pain in athletes. The application of the proper technique is related to objective tests demonstrating an abnormally posterior or anterior rotated ilium with associated sacroiliac dysfunction.

BLUMENKOPF B, BENNETT WF. **DELAYED PRESENTATION OF POSTTRAUMATIC CERVICAL DISK HERNIATION.** AJNR 1986; 7: 722-24.

Abstract: Traumatic injuries of the cervical spine are frequent, especially following motor vehicle accidents. Multiple lesions predominate, with a variable distribution according to vertebral level and anatomic structure. Injury to the

intervertebral disk has been seen in slightly less than one-third of patients. A patient with a neck injury developed obvious radiographic signs of spinal injury, but on a delayed basis. The unusual sequence of events and radiologic studies are presented.

EDEIKEN-MONROE B, WAGNER LK AND HARRIS JH. **HYPEREXTENSION DISLOCATION OF THE CERVICAL SPINE.** Am J Neuroradiol 1986; 7: 135-40.

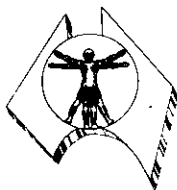
Abstract: The purpose of this report is to describe hyperextension dislocation of the cervical spine and to illustrate its often subtle radiographic features. An analysis of the lateral cervical spine radiographs in 20 patients with hyperextension dislocation of the cervical spine revealed the combination of diffuse prevertebral soft-tissue widening together with *normally* aligned cervical vertebrae in all patients with this injury. In six (30%) of 20 patients, this combination of findings was the only radiographic sign. The precise level of dislocation was indicated by a thin, transversely oriented avulsion fracture fragment arising from the anterior aspect of the inferior end-plate of the dislocated vertebra in 13 (65%) of 20 patients, by a vacuum defect in the intervertebral disk subjacent to the dislocated vertebra in three (15%), by a widened intervertebral disk space in three (15%), and by comminuted fracture of the spinous process in one (5%). Clinically, all 20 patients had facial trauma, and all had some manifestation of the acute central cervical spinal cord syndrome.

LEWIT K. **MUSCULAR PATTERNS IN THORACOLUMBAR LESIONS.** Man Med 1986; 24: 120-2.

Abstract: The thoracolumbar junction is one of the four major key transition regions; whereas at each of the other three a highly mobile structure joins a firm one, here two mobile structures meet and it is mainly the quality of motion that changes. To stabilize this region muscular forces are required, and we therefore find wide-spread spasm in lesions, which plays an important role in the clinical picture. Most typically, we find spasm of the psoas and of the thoracolumbar erector spinae muscles, and very frequently of the quadratus lumborum and of the rectus abdominis muscles. Spasm of the psoas muscle causes abdominal pain, and if severe, it produces flexion of the hip and the antalgic posture typical for acute lumbago. Spasm of the erector spinae muscle produces low back pain at its caudal points of attachment and interscapular pain owing to spasm extending as far as the midthoracic region. Spasm of the quadratus lumborum muscle causes lumbar pain and pain at the attachments, i.e. at the iliac crest and the lower ribs. Spasm of the rectus abdominis muscles may mimic abdominal pain and cause pain at the attachments at the pubic symphysis and the xiphoid process. It also produces a typical posture with the trunk thrust forward and restricted backward bending. These circumstances explain why, in the case of thoracolumbar lesions, pain is not usually felt at the site of the lesion. Any of these spasms can improve after treatment of thoracolumbar movement restriction and/or after (gravity induced) post-isometric relaxation of the muscle spasm.

MAIGNE R, MAIGNE JY. **MISINTERPRETED PAIN IN THE HIP. SYNDROME RESULTING FROM IRRITATION OF THE NERVES PASSING THROUGH THE LATERAL ABDOMINAL WALL (D12 AND L1).** Man Med 1986; 24: 116-19.

Abstract: Certain sensations of pain localized in the hip region may result from an irritation of one of the nerves (D12 and L1) that pass through the lateral abdominal wall. It is thought that such an irritation can be caused by mechanical injury, microtrauma of the dorsolumbar junction as part of the "Dorsolumbar hinge syndrome" (R. Maigne) or by local compression in the area of the crista iliaca. Our anatomical studies on this subject confirm this idea. In addition, we have reached new insights that enhance our understanding of the pathology of these nerves.



INVESTIGATIONS

REICH C, DVORAK J. **THE FUNCTIONAL EVALUATION OF CRANIOCERVICAL LIGAMENTS IN SIDEBENDING USING X-RAYS.** Manual Medicine 1986; 2:108-13.

Abstract: This study investigates the value of functional x-rays in the sidebending positions for the patients whose ligaments in the upper cervical spine have undergone destructive changes. A test group of 26 rheumatoid arthritis patients with proven anterior atlas-axis instability and a control group were examined. In each patient changes of the dens-lateral mass distance were roentgenometrically evaluated in order to determine the extent of displacement in the atlanto-axial joint. Lateral displacement of the atlas occurred with no exception in both groups to the side of the sidebending. The extent of this displacement was found to be significantly greater in the RA-group. It can be concluded that defective ligaments in the upper cervical spine become apparent on x-ray films in the sidebending position. Whether this technique may be of help in the diagnostic process of suspected lesions of the ligaments due to trauma, cannot be definitively concluded.

MALMIVAARA A, VIDEMAN T, KUOSMAE E, TROUP JDG. **RADIOGRAPHIC VS DIRECT MEASUREMENTS OF THE SPINAL CANAL OF THE THORACOLUMBAR JUNCTIONAL REGION (T10-L1) OF THE SPINE.** Spine 1986; 11:574-78.

Abstract: Midsagittal diameter (MSD) and interpedicular distance (IPD) in the thoracolumbar junctional region (T10-L1) of 24 male cadaveric spines were measured both from radiographs and directly from bones after removal of the soft tissues in order to assess the accuracy of plain radiographs. In addition surface areas of the vertebral canals were measured also from bone samples. It was found that the mean difference between bone and radiographic measurements in the IPD on different vertebral levels was 1.0 mm ($r=0.98$). The MSD was a more difficult measurement, but the correlation coefficient was still 0.70, the mean difference being 0.7 mm or less. The sum of the MSD and IPD showed good relationship with the cross sectional area of the spinal canal, and the correlation coefficient was 0.77 ($P<0.001$).

VIRAPONGSE C, GMITRO A, SARWAR M. **THE SPINE IN 3D. COMPUTED TOMOGRAPHIC REFORMATION FROM 2D AXIAL SECTIONS.** Spine 1986; 11:513-20.

Abstract: A new program (3D83, General Electric) was used to reformat three-dimensional (3D) images from two-dimensional (2D) computed tomographic axial scans in 18 patients who had routine scans of the spine. The 3D spine images were extremely true to life and could be rotated around all three principle axes (constituting a movie) so that an illusion of head-motion parallax was created. The benefit of 3D reformation with this program is primarily for preoperative planning. It appears that 3D can also effectively determine the patency of foraminal stenosis by reformatting in hemisections. Currently this program is subject to several drawbacks that require user interaction and long reconstruction time. With further improvement, 3D reformation will find increasing clinical applicability.

MONDELL DL, KELLNER WS, FELSETHAL G. **EVOCKED SENSORY NERVE ACTION POTENTIALS: EFFECT OF DIFFERENT RECORDING ELECTRODES ON DISTAL LATENCIES AND AMPLITUDES.** Arch Phys Med Rehabil 1986; 67:12-3.

Abstract: The evoked sensory nerve action potentials (ESAP) of the median nerve were studied in 20 subjects using an antidromic technique, recording the distal latency to onset and to peak, and peak to peak amplitude, using three different recording electrodes. The electrodes used were the TECA digital ring electrodes, AERO MED wire loop stretch and squeeze-type electrodes, and Neurodiagnostic finger clip electrodes. Because the Neurodiagnostic finger clip electrodes are wider than the others, they were placed at different points over the proximal and distal interphalangeal joints to evaluate any changes in the ESAP caused by different interelectrode distance. The values obtained for the distal latencies and amplitudes for each electrode were compared using the unpaired Student's *t*-test. There were no statistically significant differences found in the ESAP distal latencies to onset or peak using any of the electrodes or various placements. When comparing the amplitude responses, the only statistically significant difference was noted when the TECA digital ring electrodes were compared to a particular arrangement of the Neurodiagnostic finger clip electrodes ($p<0.05$). It was therefore concluded that any of these electrodes can be used to obtain reliable

ONO K, YONENOBU K, FUJI T, OKADA K. **ATLANTOAXIAL ROTATORY FIXATION: RADIOGRAPHIC STUDY OF ITS MECHANISM.** Spine 1985; 10:602-8.

Abstract: The mechanism of atlantoaxial rotatory fixation was investigated by means of CT scanning. During the acute stage, there was a common rotatory displacement of the occiput and atlas complex in relation to the axis. As symptom subsided spontaneously or with treatment, the displacement was reduced and the occiput and atlas complex was in normal alignment with the axis. In a few cases where survey X-ray presented persistence of a typical displacement between C1/2, there was a persistent rotatory displacement of the atlas within the occiput-atlas-axis (C0-C1-C2) complex. Here, the occiput faced in nearly the same direction as the axis and the rest of the cervical spine. This meant an interlocking of the rotated atlas between C0 and C2. Either one of the lateral mass articularion of the rotated atlas was anteriorly dislocated and interlocked. Compensatory derotation of the occiput and a hypermobility of the C0/1 articulation, limited to younger children, presumably produced such a rotatory displacement of the atlas within the C0-C1-C2 complex. Restriction of rotation and a residual postural deformity resulted from unilateral dislocation of the lateral mass articulation between C1/2 and residual rotatory displacement between C0/2, respectively. Difficulty in reducing such a postural deformity can be attributed to the fact that any manipulative force often fails to unlock the atlas within the C0-C1-C2 complex because of an excessive mobility between the C0/C1, and a ligamentocapsular contracture can be established in the lateral mass articulation of the interlocked atlas in an ignored case.

PENNELL RG, MAURER AH, BONAKDARPOUR A. **STRESS INJURIES OF THE PARS INTERARTICULARIS: RADIOLOGIC CLASSIFICATION AND INDICATIONS FOR SCINTIGRAPHY.** AJR 1985; 145:763-766.

Abstract: Lumbar radiographs and scintigrams were compared in 24 patients with low back pain. Radiographs of the pars interarticularis were classified as type 0, normal; type 1, a stress fracture with an irregular lucent line in an area of sclerosis; type 2, an evolving or healed stress injury showing either sclerosis or narrowing; or type 3, a nonunited fracture with a large lucent defect and well defined margins. Radiographs and scintigrams were abnormal in 88% (21/24) and 54% (13/24) of patients, respectively. Scintigraphy was most often positive with type 1 (73% [11/15]) and negative with type 3 abnormalities (83% [10/12]). Findings suggest that in the proper clinical setting, identification of a type 1 abnormality is sufficient to diagnose acute pars injury. If a type 2 or 3 abnormality is present, scintigraphy is used to confirm recent injury. Finally, if no radiographic abnormality is present at the site of localised pain, scintigraphy should be used to exclude stress injury not radiographically apparent.

THERY Y, BONJEAN P, CALEN S, ROQUES JC. **ANATOMICAL AND ROENTGENOLOGICAL BASIS FOR THE STUDY OF THE LUMBAR SPINE WITH THE BODY IN THE SUSPENDED POSITION.** Anat Clin 1985; 7:161-9.

Abstract: Roentgenological investigation of the lumbar spine was done in the standing and suspended position in 100 healthy adult male volunteers. Spinal and external morphology were studied. The aim of this work was to identify eventual correlations between the modifications of shape and size of the suspended lumbar spine and external morphology. Such correlations were sought to establish a functional approach to anthropometry. The results of this study demonstrated that the suspended position led to lengthening of the spine in 70% of the subjects examined, shortening of the spine in 22% and mainly straightening of the spine in 8%. Extension of the lumbar spine resulting from the suspended position is dependent upon tonic muscle activity, and the relations between the observed spinal modifications and external morphology are difficult to establish. Nevertheless, anthropometric profiles and spinal features allow identification of certain influential external morphological parameters. Furthermore, the results of this study confirm those of others devoted to elongation of the lumbar spine under horizontal traction or suspension and lead to practical conclusions.

YOH S. THE VALUE OF COMPUTED TOMOGRAPHY IN THE DIAGNOSIS OF THE ROTATOR CUFF TEARS, AND BONE AND SOFT TISSUE TUMORS. Adv Orthop Surg 1985; 9:29.

Abstract: This report has two parts. Part 1 assessed the usefulness of computed tomography (CT) in the diagnosis of rotator cuff tears. CT arthrography was performed on 21 cases of such tears. The most detailed information was visualised when a relatively low concentration of contrast material (3.25% Angiografin) was filled in the cavity, and when the shoulder joint was rotated to the maximum outwards at the side. CT arthrography demonstrated conclusive evidence of diagnosis and management in 89% of patients studied.

In part 2, the usefulness of CT in the diagnosis of bone and soft tissue tumors was assessed. CT examination provided preoperatively precise histological characteristics and anatomical localisation of the lesion. When it was available, contrast enhancement (CE) proved to be helpful in predicting the nature of tumors. The CE by intraarterial infusion, or intravenous bolus injection of contrast material during the scan, was more useful than that by intravenous drip infusion. The information regarding change of tumor size, CT number and CE were appropriate indicators that directly corresponded to responsiveness of the tumor to the chemotherapy and radiotherapy performed. Preoperative ABC classification of the tumor by information regarding its size, location, definition and anatomical relation of tumors to vital structures (neural, vascular and visceral) was done by using CT. The classification clearly corresponded to the status of patients regarding the treatment required for the patients.

OBSERVATIONS

NISSAN M. DIMENSIONS OF HUMAN LUMBAR VERTEBRAE IN THE SAGITTAL PLANE. J Biomech 1986; 19:753-8.

Abstract: Geometrical dimensions of the lumbar segments were determined from a series of lateral radiographs. A two-dimensional model of the lumbar vertebra in the sagittal plane is used. The model is based on five landmarks, which enable the determination of twelve geometrical parameters. The sample includes 157 healthy young males, 20-38 years old. Two-dimensional analysis of vertebral body height, depth and intervertebral spacing was performed. In all subjects, disc height increases from L1 to L5, while anterior height is always bigger than posterior height, which emphasises the lordotic shape of the lumbar region. Anthropometrical values are presented and geometrical relations between the lumbar segments are discussed.

ROBERTS WJ. A HYPOTHESIS ON THE PHYSIOLOGICAL BASIS FOR CAUSALGIA AND RELATED PAINS: REVIEW ARTICLE. Pain 1986; 24:297-311.

Abstract: A hypothesis is presented concerning the neuronal mechanisms which subserve the sympathetically maintained pains such as causalgia and reflex sympathetic dystrophy. The hypothesis rests on two assumptions: 1) that a high rate of firing in spinal wide-dynamic-range (WDR) or multireceptive neurons results in painful sensations and 2) that nociceptor responses associated with trauma can produce long-term sensitisation of WDR neurons. The hypothesis states that chronic sympathetically maintained pains are mediated by activity in low-threshold, myelinated mechanoreceptors, that this afferent activity results from sympathetic efferent actions upon the receptors or upon afferent fibres ending in a neuroma and that these afferent fibres evoke sufficient activity in sensitised spinal WDR neurons to produce a painful sensation.

This hypothesis is based on known characteristics of these neuronal populations studied in experimental animals and on the observed sensory disturbances reported in patients successfully treated with sympathetic blocks. This hypothesis does not require nerve injury or dystrophic tissue. It explains both the continuous pain and the allodynia that are common to these syndromes and their abolition by sympathetic block. Specific changes are proposed in the diagnosis and treatment of posttraumatic pains.

TUCCISM, HICKS JE, GROSSE G, CAMPBELL W, DANOFF J. **CERVICAL MOTION ASSESSMENT: A NEW, SIMPLE, AND ACCURATE METHOD.** Arch Phys Med Rehabil 1986; 67:225-30.

Abstract: Accurate assessment of head motion can be a useful tool in clinical studies. Since the head moves on a combination of axes in the cervical spine, evaluation of neck motion is difficult. Assessment of cervical mobility is further complicated because of inadequate reference points on the head from which to measure. Hence, numerous methods for approximating cervical range have been devised. These methods include visual estimation, radiographic analysis, schematography, photography, and a variety of goniometer devices. Disadvantages of these techniques are lack of accuracy and objectivity, radiation exposure, expense, time consumption, and equipment availability. To measure cervical mobility, a standard gravity goniometer with spirit level and head adapter was used, which allowed stabilisation. The gravity goniometer can be obtained in a variety of sizes at most hardware stores. The head adapter consists of a wood block into which an arc is carved and elastic straps suspended for securing on the head. The reliability of this instrument was tested and compared to the universal goniometer, and correlation coefficients were determined. When two experienced examiners used the universal goniometer to assess cervical motion, significant intraclass correlation coefficients (ICC) were found with three of the six criteria measures ($p < 0.05$). When one experienced and one novice examiner used the gravity goniometer with head adapter, highly significant ICC values were found for all six criteria measures ($p < 0.01$). A single experienced examiner comparing both instruments on the same subjects produced significant ICC values in four of the six criterion measures ($p < 0.01$). It was concluded that the gravity goniometer with adapter is a simple, inexpensive, and highly accurate method to measure cervical range of motion (ROM) by both experienced and novice examiners.

WELCH MJ, MacEDINGTON D, RITTER R. **MUSCULAR STRENGTH AND TEMPOROMANDIBULAR JOINT REPOSITIONING.** J Orthop Sports Phys Ther 1986; 7:236-9.

Abstract: The relationship between physical performance and the position of the temporomandibular joint has received much attention in the past few years. Some studies have shown improvement in the physical performance with the proper alignment of the jaw. However, most of these studies lack proper experimental design. This study used a double blind and placebo design. All subjects experienced to some degree improper alignment of the temporomandibular joints. After establishing baseline data, no significant differences were found in grip strength, maximum peak torque for knee extension/flexion, or total work for knee extension/flexion. Therefore, we feel that changing the position of the temporal mandibular joint does not increase muscular strength.

MALMIVAARA A, VIDEMANT, KUOSMA E, TROUP JDG. **PLAIN RADIOGRAPHIC, DISCOGRAPHIC, AND DIRECT OBSERVATIONS OF SCHMORL'S NODES IN THE THORACOLUMBAR JUNCTIONAL REGION OF THE CADAVERIC SPINE.** Spine 1987; 12:453.

Abstract: The perceivability of Schmorl's nodes in plain radiographs and discograms in the thoracolumbar junctional region (T10-L1) of the cadaveric spine was assessed by comparing the radiologic measurements with bone measurements. Schmorl's nodes in bone specimens were encountered in 19 of 24 spines studied. They were more than two times as common between vertebrae T10-11 and T11-12 as between T12 and L1 ($P < 0.01$). When the areas of actual Schmorl's nodes exceeded 0.5cm^2 (corresponding to an aperture with a diameter of 0.8cm), 47% of the nodes were seen in plain lateral radiographs and 68% in discograms. When the area measured 0.5cm^2 or less, only 24% could be perceived in plain lateral radiographs and 23% in discograms. The clinical significance of Schmorl's nodes remains uncertain as long as they are difficult to detect *in vivo*.

PERIPHERAL STRUCTURES

LOUIE JK, MOTE CD Jr. **CONTRIBUTION OF THE MUSCULATURE TO ROTATORY LAXITY AND TORSIONAL STIFFNESS AT THE KNEE.** J Biomech 1987; 20:281-300.

Abstract: The relationships between the mean rectified EMG from two muscle groups crossing the knee joint and the rotational stiffness and laxity about the longitudinal axis of the lower leg were investigated. The EMG signals from three of the quadriceps muscle group and two of the hamstring muscle group were monitored using surface electrodes. Each subject sustained self-induced muscle activity from specific muscle combinations while the foot was twisted internally and externally by the researcher. Joint rotation was measured using an electrogoniometer.

Analyses of the data showed increased joint stiffness with increased numbers of active muscles. The stiffness measurements ranged from 0.16 to 2.54 Nm degree⁻¹ depending upon the combination of active muscles. The stiffnesses measured in different tests were very repeatable with standard deviations ranging from 0.02 to 0.25 Nm degree⁻¹. Increases in joint stiffness of over 400% by activation of these muscles were measured.

KUSHNER S, REID DC. **MANIPULATION IN THE TREATMENT OF TENNIS ELBOW.** J Orthop Sports Phys Ther 1986; 7:264-72.

Abstract: With the increasing popularity of tennis there has been an increasing interest in the etiology and treatment of lateral epicondylitis. The current pathophysiology is assumed to be related to repeated wrist extension origin with an ultimate change in the histology of the area. Treatment involves exercise, the use of many modalities to treat the area locally, and more specifically when tennis is the etiology a whole variety of functional adaptations as well as a modification of equipment. Specifically, manipulation of the elbow has played a large role in the treatment of resistant tennis elbow and the large number of different named manoeuvres has led to a certain amount of confusion. The second half of the paper attempts to review these manipulations including that described by Mills, Cyriax, Kaltenborn, Mennell, and Stoddard. These manipulations seem to fall into two basic varieties: those that seek full extension and those that will produce a varus thrust. The manipulations done with the elbow in extension and the forearm in pronation have the greatest chance of affecting the contractile elements whereas those performed with a varus thrust at the elbow seem to act primarily on the capsular structures causing gapping and restoring joint play. While manipulation may be effective it always must be used in conjunction with a total treatment regime including exercise, modalities, and modification of the activities involved in the etiology.

MORRISSEY MC. **THE RELATIONSHIP BETWEEN PEAK TORQUE AND WORK OF THE QUADRICEPS AND HAMSTRINGS AFTER MENISCECTOMY.** J Orthop Sports Phys Ther 1987; 8:405-8.

Abstract: The purpose of this study was to assess the relationship between isokinetic peak torque and work of the quadriceps and hamstrings in the injured and uninjured leg after arthroscopic meniscectomy. Subjects were 19 male patients who were recovering from knee arthroscopic meniscectomy with an average follow-up time from surgery to isokinetic testing of 5 months. Testing was performed at 120, 180, and 240°/sec. A high correlation ($r=0.858-0.970$) was noted between peak torque and work for the quadriceps and hamstrings of both legs at all three testing speeds. At the slowest speed work was significantly greater than peak torque, while at the fastest speed work was significantly less than peak torque. At the middle speed, peak torque and work did not differ significantly. Work deficits clearly reflected peak torque deficits of the injured and uninjured knees. In summary, work analysis may offer little additional information to that attained by peak torque analysis.

CREIGHTON DS, OLSON VL. **EVALUATION OF RANGE OF MOTION OF THE FIRST METATARSOPHALANGEAL JOINT IN RUNNERS WITH PLANTAR FASCIITIS.** J Orthop Sports Phys Ther 1987; 8:357-61.

Abstract: Accurate assessment of range of motion of the first metatarsophalangeal joint may assist the physical therapist when dealing with plantar fasciitis. The purpose of this study was to determine whether there is any difference in the amount of flexion and or extension at the first metatarsophalangeal joint in runners with plantar fasciitis. Bilateral active and passive range of motion values at the first metatarsophalangeal joint were measured with a goniometer on

six subjects with plantar fasciitis and six subjects without the pathology while their leg was stabilised at the ankle and forefoot in an adapted orthosis. The results indicate a statistically significant decrease in active extension, passive extension, and passive flexion in runners with plantar fasciitis. Due to the loss of stability in the medial longitudinal arch which accompanies decreased extension range of motion at the first metatarsophalangeal joint, specific evaluation of this joint is needed when the physical therapist is treating a patient with plantar fasciitis.

MUNRO CF, MILLER DI, FUGLEVAND AJ. **GROUND REACTION FORCES IN RUNNING: A RE-EXAMINATION.** J Biomech 1987; 20:147-55.

Abstract: Ground reaction force (GRF) data were collected on twenty adult males during running stance to establish normative standards to aid in assessment of the gait of atypical runners. Subjects ran between 30 and 40 trials across a Kistler 0.6 x 0.9 m force platform at self-selected speeds ranging from 2.5 to 5.5 ms⁻¹. Best fit polynomials for a given descriptor variable were constructed for each subject and the polynomials were evaluated as a function of running speed. Predicted means and standard deviations (based on the polynomials) were calculated and multivariate analyses of variance were performed. The descriptor variables: impact peak, loading rate, thrust maximum, decay rate, average vertical GRF, change in vertical velocity, braking impulse, propulsive impulse and stance time were determined to be running speed dependent ($p < 0.001$). Specific patterns associated with the breaking component of the antero-posterior GRF of heel-strikers included single, double and multiple peaks. Three dimensional graphic displays showed that, despite considerable group variability in medial-lateral GRF-time histories, consistency was evident in the patterns of individuals across speeds. Individual right-left asymmetries were clearly shown in these displays.

NEWCOMBE WR, REPO RU, EATON NB, OCCHIONORELLI J. **A MECHANICAL EVALUATION OF AN ELASTIC FEMORAL PROSTHETIC STEM.** J Biomech 1987; 20:179-87.

Abstract: Studies are being conducted in our laboratory to test the concept of introducing an elastomer to attenuate and damp forces applied to the bone interface in a major weightbearing joint replacement prosthesis. An analogue of a fully constrained intramedullary stem type prosthesis has been developed in a segmental femoral replacement prosthesis of the dog. The layer of silastic was introduced to damp forces at the bone-prosthesis interface. This paper describes the response of this elastomer prosthesis to torsional and bending loads, and defines the upper limits of elastomer strain. The low modulus silastic displayed surprisingly low strain for applied loads, particularly in bending tests, in this prosthetic configuration. The results of these mechanical studies serve as a bench mark for the eventual design and material selection of an elastomer for human prosthetic use.

WALMSLEY RP, PEARSON N, STYMIEST P. **ECCENTRIC WRIST EXTENSOR CONTRACTIONS AND THE FORCE VELOCITY RELATIONSHIP IN MUSCLE.** J Orthop Sports Phys Ther 1986; 8:288-93.

Abstract: The torque produced by the wrist extensors during maximal isometric and isokinetic eccentric contractions has been investigated. The torque produced by eccentric contractions was measured at three different velocities: 0.36, 0.93 and 1.64 cm/sec. The speeds of contraction were generated by a specially designed apparatus, consisting of a gear drive and an electric motor that would maintain its speed irrespective of the load applied. Tension produced by the wrist extensors was measured using a load cell. The results indicated that eccentric contractions of the wrist extensors exceed those produced by isometric contractions. The force-velocity relationship during eccentric contractions was determined to be different from that during concentric contractions. Force values were found to increase as the velocity of eccentric contraction increased. No significant effect of wrist joint angle on torque values was found, nor was there an interaction effect of velocity and joint angle. The implications for rehabilitation of these findings are outlined.

McCOY GF, McCREA JD, BEVERLAND DE, KERNOHAN WG, MOLLAN RAB. **VIBRATION ARTHROGRAPHY AS A DIAGNOSTIC AID IN DISEASES OF THE KNEE. A PRELIMINARY REPORT.** J Bone Joint Surg 1987; 69-B:288-93.

Abstract: The detection and recording of vibration emission from human joints, a technique which we have termed 'vibration arthrography', is a sensitive, non-invasive method for the objective study of the locomotor system. Using vibration sensors attached to bony prominences around the knee, we studied the joints of both normal and symptomatic

subjects. Normal subjects produced three signal types - physiological patellofemoral crepitus, patellar clicks, and the lateral band signal. In symptomatic subjects we identified and categorised many signal types and related them to pathology. Lesions of the menisci produced distinctive signals, and it was possible not only to lateralise the tear, but in many cases to determine the type of meniscal injury present. Vibration arthrography promises to be a useful tool in the non-invasive diagnosis of knee disorders.

WALKER JM. EXERCISE AND ITS INFLUENCE ON AGING IN RAT KNEE JOINTS. J Orthop Sports Phys Ther 1986; 8:310-19.

Abstract: The interaction between natural ageing and exercise in the knee joints of 38 female Wistar rats, 14 of which performed treadmill exercise for 6 or 12 months was assessed. Qualitative morphological changes observed with age in joint tissues other than cartilage of sedentary and exercised animals were similar. Chondrocyte counts were only significantly different between groups of young and older control animals in the lateral tibial condyle with older animals having a higher median than younger control animals. Defects in the articular cartilage were observed in animals of all ages and in both groups; however, exercised animals showed a significantly higher frequency and greater severity of defects than age-matched sedentary animals. The interaction between exercise intensity and age-related changes in the rat warrants further investigation since these observations suggest exercise may increase microtrauma to the articular cartilage.

VEGTER J. THE INFLUENCE OF JOINT POSTURE ON INTRA-ARTICULAR PRESSURES. A STUDY OF TRANSIENT SYNOVITIS AND PERTHES' DISEASE. J Bone Joint Surg 1987; 69-B:71-4.

Abstract: The pathogenesis of Perthes' disease has been related to increased intra-articular pressure secondary to a joint effusion. The pressure within the hip in different positions was measured in eight children with transient synovitis and four with the synovial stage of Perthes' disease. In the position of comfort for the hip this pressure was always less than the arteriolar blood pressure and in a supine position it did not exceed the systolic blood pressure. However, in extension with medial rotation the intra-articular pressure always became several times the systolic blood pressure. This high pressure was also recorded in the stable lateral position which occurs normally during sleep.

It is concluded that in the presence of a synovial effusion in the hip, a position of extension and medial rotation causes an increase in intra-articular pressure which may compromise the blood supply to the capital epiphysis of the femur.

KIRKENDALL DT, STREET GM. MECHANICAL JUMPING POWER IN ATHLETES. Br J Sports Med 1986; 20:163-4.

Abstract: The Wingate cycle ergometer test is a widely used test of sustained muscular power. A limitation of the test is the lack of development and retrieval of stored elastic energy due to a lack of an eccentric phase. To measure mechanical power output of the entire stretch-shortening cycle, the test of Bosco et al (1983) was administered to 119 male athletes in 7 different activities during their pre-participation evaluations. The sports tested were indoor soccer, American football and ballet (professionals), outdoor soccer, basketball and wrestling (collegiate) and amateur bobsled. Results showed the overall average power output to be 20.37 W.kg⁻¹ for the 60s reciprocal jumping test. Ballet dancers generated significantly less mechanical power than indoor soccer, basketball and bobsled athletes, while wrestlers generated significantly less power than indoor soccer and basketball athletes (all $p < 0.05$). No other between-sport differences were seen. A subset of indoor soccer players ($n=10$) were retested after 4 months of training. Power improved from 20.8 to 24.3 W.kg⁻¹ ($p < 0.05$). While between sport differences were limited, training differences in one subset of athletes were readily identified.

PANUSH RS, SCHMIDT C, CALDWELL JR et al. IS RUNNING ASSOCIATED WITH DEGENERATIVE JOINT DISEASE? JAMA 1986; 255:1152-4.

Abstract: Little information is available regarding the long-term effects, if any, of running on the musculoskeletal system. We therefore compared the prevalence of degenerative joint disease among 17 male runners [mean age, 56 years; height, 180 cm (5 ft 11 in); and weight, 73.02 kg (161 lb)] with 18 male nonrunners [mean age, 60 years, height, 178 cm (5 ft 10 in); and weight, 78 kg (171 lb)]. Running subjects (53% marathoners) ran a mean of 44.8 km (28

miles)/wk for 12 years. Pain and swelling of hips, knees, ankles, and feet and other musculoskeletal complaints among runners were comparable with those among nonrunners. Radiologic examinations (for osteophytes, cartilage thickness, and grade of degeneration) also were without notable differences among groups. We did not find an increased prevalence of osteoarthritis among the runners. Our observations suggest, within the limits of our study, that long-duration, high-mileage running need not be associated with premature degenerative joint disease in the lower extremities.

SANDZEN SC. **CARPAL TUNNEL SYNDROME: MANAGING THE CAUSE AND THE SYMPTOMS.** J Musculoskeletal Med 1985; 2:22-31.

Abstract: Carpal tunnel syndrome may often be a symptom of an underlying disorder, and this disorder warrants treatment. Patients may also require treatment of median nerve compression directly, however. Conservative methods of managing carpal tunnel syndrome include medications (primarily aspirin and other nonsteroidal anti-inflammatory agents), immobilisation and corticosteroid injections. Surgical decompression can also be performed. Choose conservative treatment for any patient who has minimal symptoms of short duration; among the indications for surgery are more severe or long-standing symptoms, persistent dysesthesia, thenar weakness or atrophy and acute median neurapraxia caused by a closed space or closed compartment compression.

RICHARDSON C, BULLOCK MI. **CHANGES IN MUSCLE ACTIVITY DURING FAST, ALTERNATING FLEXION-EXTENSION MOVEMENTS OF THE KNEE.** Scand J Rehab Med 1986; 18:51-8.

Abstract: The effects of high frequency alternating knee flexion-extension on muscle activity of the quadriceps and hamstring muscle groups has been investigated. Standard loads were used for each subject. The muscle activity in vastus medialis, vastus lateralis, rectus femoris and the lateral hamstrings were recorded by electromyography during increasing velocities. Rectus femoris and hamstrings were found to increase their activities significantly with increasing speed while vastus medialis and vastus lateralis showed no such change. The individual thigh muscles thus differ in function in relation to the velocity of movement.

SOBALLE K, HANSEN AJ. **LATE RESULTS AFTER MENISCECTOMY IN CHILDREN.** INJURY 1987; 18:182-4.

Abstract: Seventy-five children undergoing 77 meniscectomies have been reviewed from 1 to 30 years (mean 15) after operation in order to determine the late results of meniscectomy. Arthroscopy of the patients with a poor result was performed at the follow-up. In 30 per cent osteoarthrosis was diagnosed, all with follow-up times from 19 to 25 years. Delay in operation resulted in worse results. The younger the patient the worse the result. The benefit of operation was less in girls than in boys. Bucket-handle lesions and peripheral tears produced the best results after meniscectomy. Fifty-eight per cent of men and 26 per cent of women had symptom-free knees at follow-up. Removing a meniscus is not a benign procedure. Only 44 per cent of patients in whom a damaged meniscus and 17 per cent in whom a normal meniscus had been removed were without symptoms. These results stress the need for making an accurate diagnosis by careful examination and arthroscopy before embarking on meniscectomy in children. Efforts to preserve the meniscus in children must be made whenever possible.

PRATT DJ, PAPAGIANNOPOULOS G, REES PH, QUINNELL R. **THE EFFECTS OF MEDULLARY REAMING ON THE TORSIONAL STRENGTH OF THE FEMUR.** Injury 1987; 18:177-9.

Abstract: The authors have investigated the effect on the torsional strength of the bone of reaming the medulla of the femur from 12 to 16 mm in steps of 1 mm. Five groups of femurs, with 10 pairs in each, were tested comparatively in torsional loading and the torque required to cause fracture and the angle through which the bone had twisted at fracture were directly recorded for each pair. The results of maximum torque at failure (expressed as a proportion of the same parameter for the unreamed femur) plotted against the ratio of bone shaft diameter to reamed diameter showed a good correlation. The proportional maximum torque was found to range from 0.63 (at 12 mm) to 0.36 (at 16 mm) with a sharp transition between 14 and 15 mm. The drastic reduction was felt to be important for both the surgeon and the patient.

ANTICH TJ, RANDALL CC, WESTBROOK RA, MORRISSEY MC, BREWSTER CE. **EVALUATION OF KNEE EXTENSOR MECHANISM DISORDERS: CLINICAL PRESENTATION OF 112 PATIENTS.** J Orthop Sports Phys Ther 1986; 8:248-54.

Abstract: Results of physical therapy evaluation of 112 patients with extensor mechanism disorders (chondromalacia patella, infrapatellar tendinitis, and peripatellar pain) are presented. An equal number of male and female patients were evaluated and of the 73 patients with unilateral involvement (65%) there were equal numbers of right and left involved knees. Running was the activity most commonly associated with pain followed by basketball and tennis. Stairclimbing was painful in 79% of the patients, with ascending being more painful than descending in patients reporting a clear-cut difference. Hamstring and quadriceps tightness was statistically significant relative to the uninvolved limb although clinically, negligible differences were measured. The inferior pole of the patella was the most tender site to palpation, followed by medial peripatellar structures, then lateral sites. Biomechanical metalignment was not detected by the attending therapist in the majority of patients. The authors emphasise careful assessment of flexibility, quadriceps (VMO/VL) imbalance, and biomechanical alignment in performing a thorough evaluation of patients with extensor mechanism disorders.

STYF J, KORNER L, SUURKULA M. **INTRAMUSCULAR PRESSURE AND MUSCLE BLOOD FLOW DURING EXERCISE IN CHRONIC COMPARTMENT SYNDROME.** J Bone Joint Surg 1987; 69-B:301-5.

Abstract: In nine patients with chronic compartment syndrome, the intramuscular pressure and muscle blood flow during constant dynamic exercise was studied by the microcapillary infusion method and by the 133-xenon clearance technique. Although muscle blood flow was normal at the start of exercise, pain and impaired muscle function eventually developed; muscle blood flow decreased while muscle relaxation pressure increased. The changes of muscle blood flow could not be correlated with any change of mean muscle pressure during exercise.

Eight months after fasciotomy the exercise test was repeated. Patients experienced no symptoms and the muscle relaxation pressure and blood flow during exercise were normal. It is suggested that chronic compartment syndrome is due to increased muscle relaxation pressure during exercise which causes decreased muscle blood flow, leading to ischaemic pain and impaired muscle function.

DULJ. **A BIOMECHANICAL MODEL TO QUANTIFY SHOULDER LOAD AT THE WORK PLACE.** Clinical Biomechanics 1988; 3:124-128.

Abstract: A simple two-dimensional biomechanical model of the shoulder has been developed to quantify shoulder muscle load, joint load and endurance time in work situations. The model is applicable to the analysis of working postures requiring elevated upper arm positions in the plane of the scapula, with the trunk upright, and the elbow flexed at 90°. The only input variable of the model, to be measured in the work situation, is the angle between the upper arm and the vertical line. In addition, the total body weight and the upper arm length should be known. For a given arm position, the model predicts the individual forces in the deltoid and supraspinatus muscles, and the reaction force at the glenohumeral joint. Furthermore, the model estimates the endurance time of the given arm position, which is the period of time until the shoulder muscles become fatigued.

The results show that maximum muscle forces occur at 80° of arm elevation, when the deltoid force is about 22% of its maximum force, and the supraspinatus 25%. The corresponding glenohumeral joint force is about 43% of total body weight. At 80° of arm elevation, the endurance time is about 5 minutes. If a working posture is maintained for more than 1 hour, the model suggests that the elevation angle between the upper arm and the trunk should be less than 15°, in order to prevent muscular fatigue in the shoulder muscles.

Relevance

The model can be used in ergonomic studies to estimate shoulder muscle and joint loads in elevated arm postures, and to estimate the working time until the shoulder muscles become fatigued.

HAMILL J, MORIN G, CLARKSON PM, ANDRES RO. **EXERCISE MODERATION OF FOOT FUNCTION DURING WALKING WITH A RE-USABLE SEMIRIGID ANKLE ORTHOSIS.** Clinical Biomechanics 1988; 3:153-158.

Summary: A study was conducted to investigate the effects of a re-usable semirigid ankle orthosis on the support phase of the walking stride in both pre- and post-exercise conditions. Ten young, adult males were required to complete ten trials in each of four orthosis/no orthosis and pre-/post-exercise conditions. Data were collected via a force platform and a high speed camera. The analysis consisted of the evaluation of selected ground reaction force parameters and kinematic parameters describing rearfoot motion. The exercise regimen consisted of 70 maximal eccentric actions of the ankle everters, with 15s between each action. The results revealed significant differences between the orthosis/no orthosis conditions for the variables describing the mediolateral action of the ankle during walking. Only the rearfoot touchdown angle was affected by the exercise regimen. The data indicated that the semirigid orthosis moderated ankle joint mechanics, although the measured values were within normal bounds.

Relevance: Although ankle injuries account for the majority of injuries in athletics, efforts to produce a prophylactic orthosis for the ankle have generally not been successful. The semirigid orthosis used in this study appeared to accomplish the goals of a successful prophylactic: moderate ankle joint motion within the normal bounds of the joint action.

OAKLEY T, PRATT DJ. **SKELETAL TRANSIENTS DURING HEEL AND TOW STRIKE RUNNING AND THE EFFECTIVENESS OF SOME MATERIALS IN THEIR ATTENUATION.** Clinical Biomechanics 1988;3:159

Summary: Because of the increased popularity of running, interest has focussed on ways of reducing injurious skeletal shocks. This paper examines heel and toe strike running styles and the effect of shock attenuating materials in reducing foot/floor contact forces and skeletal shocks. Using a force plate and an accelerometer, 18 volunteers (10 men, 8 women) were studied and the following observations made. Firstly, toe striking reduced the skeletal transients and the rate of rise of foot loading. Secondly, the three materials studied (PPT, Viscolas and Cleron) all reduced the rate of foot loading in heel strike, but only one (PPT) affected the skeletal transient peak height during toe strike. No other significant results were obtained.

Relevance: With the increase in running as a pastime and the causative link between excessive skeletal shocks and injuries during running, a study to examine ways of reducing these shocks gives information which may benefit participants.

SIGHOLM G, STYF J, HERBERTS P. **SUBACROMIAL PRESSURE DURING DIAGNOSTIC SHOULDER TESTS.** Clinical Biomechanics 1988;3:187-189.

Summary: The pressure in the subacromial bursa during passive provocation tests and during active motion was recorded in five healthy persons, and in seven patients with a subacromial pain syndrome. During the passive impingement test, the mean bursa pressure increased from 6 to 56 mmHg in healthy persons and from 8 to 45 mmHg in the patients. A passive test for anterior glenohumeral instability yielded bursa pressures below 0 mmHg in both groups. Active flexion of the arm at the shoulder produced a pressure increase up to 90° and a pressure decrease between 90 and 180° of flexion for both groups.

Relevance: Subacromial pressures closely reflect changes in anatomical configuration in the shoulder during two passive clinical shoulder tests. Pressure monitoring may be a useful tool in studies of shoulder and arm motion and load.

THERAPEUTICS

LEWENBERG A. **THE TREATMENT OF CHRONIC HEADACHE WITH AN ACUPUNCTURE/ANTIDEPRESSANT COMBINATION.** *Am J Acupunct* 1986; 14:47-9.

Abstract: A treatment for chronic headache is described. The treatment combined acupuncture and medication with an antidepressive agent (maprotiline hydrochloride). The antidepressant acts synergistically with acupuncture, enhancing its efficacy in relieving pain, insomnia, and depression, and reducing the number and frequency of required treatment sessions. Because of the synergistic action, the antidepressant is effective at doses far below the normal therapeutic doses and too low to produce side effects. The treatment provides speedy and lasting relief to the great majority of patients, including those with a long history of daily and refractory headaches.

LYNCH MC, TAYLOR JF. **FACET JOINT INJECTION FOR LOW BACK PAIN.** *J Bone Joint Surg (Br)* 1986; 68-B:138-41.

Abstract: Therapeutic injection of facet joints is now widely practised, but British experience has been infrequently reported. We studied the results of injecting facet joints with corticosteroid preparation in 50 patients suffering from the "facet syndrome". Our series included a number of extra-articular injections, and these "failed injections" provide a useful control group. Results indicate that only intra-articular injections are effective; certainty of joint penetration can be ensured only by the routine use of joint arthrography.

OLMARKER K, RYDEVIK B, DAHLIN L, DANIELSEN N, NORDBORG C. **EFFECTS OF EPIDURAL AND INTRATHECAL APPLICATION OF COLLAGENASE IN THE LUMBAR SPINE: An Experimental Study in Rabbits.** *Spine* 1987; 12:477.

Abstract: An experimental model is described in which collagenase in different concentrations and volumes were applied epidurally or intrathecally in the rabbit lumbar spine. This made it possible to study the tissue effects in a situation similar to that of collagenase leaking from a disc or accidental epidural or intrathecal injection at chemonucleolysis. Epidurally applied collagenase, in higher concentration, caused a local thinning of the dura. This effect was reduced at lower concentrations and volumes. Intrathecally injected collagenase, even in small amounts, caused intrathecal haemorrhage and acute paraplegia in the hind limbs. Therefore, in the clinical situation, intrathecal injection of collagenase must be avoided.

AMLIE E, WEBER H, HOLMEI. **TREATMENT OF ACUTE LOW-BACK PAIN WITH PIROXICAM: RESULTS OF A DOUBLE-BLIND PLACEBO-CONTROLLED TRIAL.** *Spine* 1987; 12:473.

Abstract: Twenty-seven investigators participated in a double-blind, parallel placebo-controlled trial of piroxicam involving 278 patients with acute low back pain. Therapy commenced within 48 hours of the injury and continued for 7 days. The drug was given in the recommended regimen of 40 mg once daily for the first 2 days and 20 mg once daily thereafter. After 3 days of therapy, piroxicam patients showed a statistically greater amount of pain relief in the lying ($P < 0.001$), sitting ($P < 0.01$), and standing ($P < 0.01$) positions, but after 7 days the difference between treatments was no longer significant. After 1 week's therapy, however, the requirement for additional analgesic was significantly lower in the piroxicam group ($P < 0.05$), and more piroxicam than placebo patients (42 versus 28) had returned to work ($P < 0.05$). Tolerant was excellent in most patients, with only 13% of the piroxicam and 17% of the placebo group reporting adverse effects of mainly mild or moderate severity. The profile of the adverse effects was similar for both treatments. Piroxicam can provide effective relief of acute low-back pain with good toleration; it should be considered for use in the initial treatment of this condition.

VIDEMAN T. **EXPERIMENTAL MODELS OF OSTEOARTHRITIS: THE ROLE OF IMMOBILISATION.** *Clinical Biomechanics* 1987; 2:223-229.

Abstract: Evidence is reviewed from animal experiments supporting the hypothesis that immobilisation, for whatever reason, is one of the pathogenetic factors in musculoskeletal degeneration. It shows beyond reasonable doubt that

immobilisation is not only a cause of osteoarthritis but that it delays the healing process.

LAWLIS GF, SELBY D, HINNANT D, McCOY CE. **REDUCTION OF POSTOPERATIVE PAIN PARAMETERS BY PRESURGICAL RELAXATION INSTRUCTIONS FOR SPINAL PAIN PATIENTS.** Spine 1985; 10:649-51.

Abstract: This study investigated the effects of a relaxation instruction session conducted presurgically with postsurgical pain parameters for patients undergoing spinal surgery. Results indicated that the relaxation group ($n=50$), as compared with an equivalent group ($n=50$), matched to type of surgery and sex type; workers compensation status had significant reduction of days of hospitalisation, complaints noted by nurses, and medications (primarily Demerol and Phenaphen). Sex type, age, and workers compensation status were not significant factors regarding these outcome measures. The results were considered in light of the anxiety/pain explanation of pain sensitivities with implications for health care with spinal pain surgical candidates.

BULSTRODE SJ, BAREFOOT J, HARRISON RA, CLARKE AK. **THE ROLE OF PASSIVE STRETCHING IN THE TREATMENT OF ANKYLOSING SPONDYLITIS.** Br J Rheumatol 1987; 26:40-2.

Abstract: A controlled study of 39 consecutively-admitted patients with ankylosing spondylitis was conducted to assess the effects of daily passive stretching of the hip joints during a 3-week in-patient physiotherapy course. Measurements were performed by an independent assessor on admission, at discharge and six months after discharge.

Results showed that passive stretching resulted in a significant increase in the range of all movements of the hip joints except flexion during the physiotherapy course.

Follow-up at 6 months in seven patients suggested that this increase in range of movement could be maintained by patients who had been performing the stretching exercises regularly.

We suggest that the inclusion of passive stretching of the hip joint in the treatment of patients with ankylosing spondylitis will increase the range of movement and thus improve function and influence posture.

DOLAN P, ADAMS MA, HUTTON WC. **THE SHORT-TERM EFFECTS OF CHYMOPAPAIN ON INTERVERTEBRAL DISCS.** J Bone Joint Surg 1987; 69-B:422-8.

Abstract: Cadaveric lumbar discs were injected with chymopapain and subjected to a series of mechanical tests over a period of up to 19 hours. Discs from the same spine injected with saline were used as controls. The results showed that chymopapain had no measurable effect on the mechanical properties of the disc apart from the increased height and stiffening caused by fluid injection. Another series of tests on isolated pieces of disc material showed that chymopapain could reduce the size of prolapsed nuclear material by 24% in one hour and by 80% in 48 hours.

It is concluded that, in the short-term, chymopapain has a negligible effect on the mechanics of a disc but it can reduce the size of any prolapsed nuclear material with which it comes in contact.

GOTFRIED Y, BRADFORD DS, OEGEMA TR. **FACET JOINT CHANGES AFTER CHEMONUCLEOLYSIS-INDUCED DISC SPACE NARROWING.** Spine 1986; 11:944-50

Abstract: Changes on facet joint articular cartilage biology after chymopapain-induced disc height loss were determined in adult mongrel dogs. Disc height decreased to 50% at 2 weeks and returned to 80% at 6 months. The biochemistry and histology of the involved-level facet joints were followed at 2 weeks, 6 weeks, 3 months and 6 months after the injection. X-ray study showed a narrowing of the joint space and overlap of the facet joints at 6 weeks and at 3 months. Some return toward normal appearance was noted at 6 months. There was a loss of Safranin-O stain at 6 weeks, which persisted at 3 months, although some cells showed increased Safranin-O staining in the surrounding matrix. This was further improved at 6 months. The water content was unchanged early, but had decreased significantly at 6 weeks. The hexuronic acid content, already dropping at 2 weeks, was significantly lower at 6 weeks, at 3 months, and at 6 months. However, by 6 months, it had increased, compared with the 3-month value. Synthesis

of proteoglycan was depressed only at 6 weeks. Similar changes were found in the facet cartilage in the joints above and below the last injected disc level. Results of this study would suggest that there is a cause-and-effect relationship between disc pathology and facet pathology and this can affect adjacent disc facet-joint biology. The initial facet lesion described appears to be potentially reversible, but a long-term disc height decrease might be expected to cause irreversible osteoarthritic-like changes in the adjacent facet joint

STROJNIK P, ACIMOVIC R, VAVKEN E, SIMIC V, STANIC U. TREATMENT OF DROP FOOT USING AN IMPLANTABLE PERONEAL UNDERKNEE STIMULATOR. Scand J Rehab Med 1987; 19: 33-43

Abstract: An implantable peroneal stimulator has been developed to improve the rehabilitation of the drop foot patients who cannot use or refuse the use of conventionally applied peroneal braces. The small size promotes convenient attachment on the stimulation site after a minor surgical intervention. During the past two years twenty implants have been applied. The influence of different stimulation parameters upon the correction of anomalies during walking has been studied using clinical and computer-supported assessment. Possible noxious effects on the peroneal nerve have been studied by measuring nerve conduction velocity. The stimulator is well accepted by patients. Clinical observations show a significant correction of equinovarus and improved gait.

AUGUSTINSSON LE, SULLIVAN L, SULLIVAN M. PHYSICAL, PSYCHOLOGIC, AND SOCIAL FUNCTION IN CHRONIC PAIN PATIENTS AFTER EPIDURAL SPINAL ELECTRICAL STIMULATION. Spine (Eur Ed) 1986; 11: 111-19.

Abstract: The overall function, pain, and mood disturbance of 54 patients with benign chronic pain were studied as to their response to epidural spinal electrical stimulation (ESES) more than 12 months after the implantation of ESES electrodes. Both responder ($n = 23$) and nonresponder ($n = 31$) pain patients demonstrated extensively worse physical and psychosocial function on the Sickness Impact Profile (SIP) and worse self-rated mood disturbance on the Mood Adjective Check List (MACL) than a control population sample. Responders to ESES were insignificantly less impaired in physical functions of daily life than nonresponders, but clearly less inhibited in the social pattern of contact. Self-rated pain sensation differed 36% between responders and nonresponders, and the pain measures of all pain patients correlated with total mood disturbance on the MACL and with its dimensions for depression and fatigue. Social characteristics, sex, diagnoses comorbidity, and duration of pain did not discriminate. In a supplementary prospective short-term study, pain ratings had improved by 30% 3 weeks after implantations. The night sleep and general psychic balance (SIP category emotional behavior) were then also significantly improved. A shortened SIP version of 8 items optimizing responder-nonresponder differences and 12 items of mood disturbance are suggested to supplement pain ratings for overall assessment of chronic pain patients. A wider usage of ESES is recommended for pain patients who can comply to the regimen, because the surgical technique is now simple and safe.

BATRA YK. ACUPUNCTURE IN THE TREATMENT OF MIGRAINE. Am J Acupunct 1986; 14: 135-8.

Abstract: Twenty patients subject to frequent attacks of migraine who had not responded to conventional therapy, participated in a study to evaluate the effectiveness of acupuncture. Treatment was administered thrice weekly. Three months after the last sitting, results were excellent in 30% of cases, effective in 35%, slightly effective in 25% of the cases, and ineffective in 10%. These figures suggest that acupuncture be tried in patients suffering from migraine who are resistant to other forms of therapy.

BROWN MD, TOMPKINS JS. CHEMONUCLEOLYSIS (DISCOLYSIS) WITH COLLAGENASE. Spine (Eur Ed) 1986; 11: 123-30.

Abstract: Fifty-four patients with proven lumbar disc displacement were treated by intradiscal injection of collagenase (Nucleolysin) between April 1981 and January 1984. Follow-up by history and physical examination, phone survey, and/or mail survey shows 72% success rate (excellent, good, and fair) and 28% poor or unsuccessful results. No patient was made worse by the treatment. Success rate was greater in patients older than the age of 50 years, male patients, and patients with pain complaints of longer than 4 months' duration. The presence of a list and/or crossed straight leg raising and/or straight leg raising positive less than 30° was associated with a poor prognosis. Discography prior to collagenase injection did not compromise the outcome of treatment. Postinjection changes in the CT scan correlated

with a satisfactory outcome of treatment. Findings at surgery in patients who failed to obtain relief following collagenase injection did not show a specific deleterious effect of the enzyme, nor were the expected results from surgery compromised by a previous unsuccessful intradiscal collagenase injection.

MAYER TG, GATCHEL RJ, KISHINO N, ET AL. **OBJECTIVE ASSESSMENT OF SPINE FUNCTION FOLLOWING INDUSTRIAL INJURY: A PROSPECTIVE STUDY WITH COMPARISON GROUP AND ONE-YEAR FOLLOW UP.** Spine 1985; 10: 482-93.

Abstract: Objective functional capacity measurement techniques were used to guide a treatment program for a group of 66 chronic back pain patients. These patients were compared with a group of 38 chronic patients who were not administered the treatment program. Outcome data were collected by telephone survey at an average 1-year follow-up. In addition, functional capacity measures were collected for treatment group patients on admission and follow-up evaluations. Results demonstrated that the functional capacity measures collected for the treatment group improved in approximately 80% of the patients. These changes were also accompanied by positive changes in psychological measures. In addition, at 1 yr follow-up, the treatment group had approximately twice the rate of patients who returned to work, relative to the comparison group. Additional surgery rates were comparable for both groups (6% in the treatment and 7% in the comparison group), but the frequency of additional health-care professional visits was substantially higher in the comparison group. The findings suggest that quantitative functional capacity measures can give objective evidence of patient physical abilities and degree of effort and can significantly guide the clinician in administering an effective treatment program.

NOTO K, GRANT P. **A COMPARATIVE STUDY OF NEURAL STIMULATION AND CONVENTIONAL PHYSICAL THERAPY MODALITIES.** Am J Acupuncture 1985; 13: 347-54.

Abstract: Data comparing the effectiveness of neural stimulation and conventional methods of treatment are presented. A study was conducted in which 120 patients were randomly assigned to an experimental group or a control group. The control group was treated with any one or a combination of conventional therapeutic modalities. The experimental group was treated by only microamperage neural stimulation utilizing an electronic device called the Electro-Acuscope 80. It is shown that 18.3% of the Electro-Acuscope group reported requiring only one treatment, 48.3% a range of two to six treatments, and 8.3 eleven or more treatments for resolution of pain complaints, whereas 1.7% in the conventional-only group reported requiring only one treatment, 20% two to six treatments, and 55% required eleven or more treatments for resolution of pain. Statistical analysis of the data revealed that neural stimulation was superior to conventional therapy in total number of treatments required; severity of side effects; treatment cost; and patient satisfaction. Microneural stimulation appears to have considerable merit in the treatment of physical injuries.

OIWA T, HIRABAYASHI K, UZAWA M, OHIRA T. **EXPERIMENTAL STUDY ON POSTLAMINECTOMY DETERIORATION OF CERVICAL SPONDYLOTIC MYELOPATHY: INFLUENCES OF INTRADURAL SURGERY AND PERSISTENT SPINAL BLOCK.** Spine 1985; 10: 717-21.

Abstract: This experiment studied the postoperative changes around the dural tube at the site of cervical laminectomy, which are influenced by intradural operative procedures and the flow of cerebrospinal fluid. Forty dogs were divided into four groups in accordance with the type of decompressive procedure done, and three types of dural surgery were added: none (laminectomy alone), dura resection, or arachnoid resection. While the scar tissue did not adhere to the spinal cord after arachnoid resection in normal dogs, adhesion of scar to spinal cord was seen to a small extent after arachnoid resection with sufficient posterior decompression in dogs whose spinal cord was compressed anteriorly by a screw through the vertebral body. In the cases with insufficient posterior decompression, adherence was observed much more extensively.

Official Journal of

FIMM

**Fédération Internationale
de Médecine Manuelle**

**International Federation
for Manual Medicine**



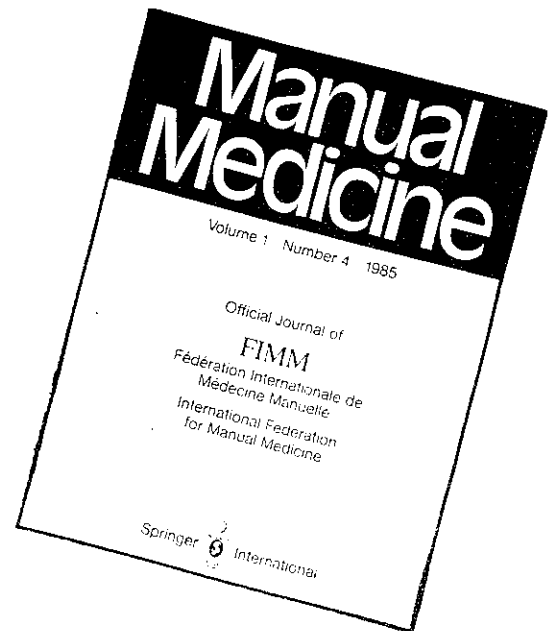
North American Academy of Manipulative Medicine
Australian Association of Musculoskeletal Medicine
Belgisch Verbond voor Manuele Geneeskunde
British Association of Manipulative Medicine Ltd.
Commission for Manual and Reflex Therapy in the Section for Rehabilitation
of the Medical Association J.E. Purkinje (Prague)
Dansk Selskab for Manuel Medicin
Deutsche Gesellschaft für Manuelle Medizin e.V.
Sociedad Española de Medicina Ortopédica y Terapéutica Manual
Finnish Association of Manual Medicine
Société Française de Médecine Orthopédique et Thérapeutiques Manuelles
Società Italiana di Medicina Fisica e Riabilitazione - Sezione di Medicina
Manuale
Société Luxembourgeoise de Médecine Manuelle a.s.b.l.
Nederlandse Vereniging van Artsen voor Manuele Geneeskunde
The New Zealand Association of Musculo-Skeletal Medicine
Norwegian Society for Manual Medicine
Österreichische Ärztesgesellschaft für manuelle Medizin
Schweizerische Aerztegesellschaft für Manuelle Medizin
Svensk Förening för Ortopedisk Medicin

Manual Medicine, founded in cooperation with the well-established German journal *Manuelle Medizin*, fulfills the long-standing need for an exchange of information among practitioners of manual medicine all over the world. Reflecting the growing importance of this field, **Manual Medicine** publishes articles exclusively in English under the auspices of **Fédération Internationale de Médecine Manuelle - FIMM**, which currently includes national societies in Europe, North America, Australia, and New Zealand.

Manual Medicine presents new developments of interest to the international reader, featuring:

1. review articles,
2. original contributions,
3. specially translated articles from the German journal **Manuelle Medizin**,
4. commentaries on current work in the field,
5. book reviews,
6. FIMM news (from the member societies).

Subscriptions: annual rate DM 116.00 plus carriage charges, making a total of DM 134.95 for Surface Airmail Lifted delivery. Airmail delivery rates on request. Orders should be sent to the publishers, Springer-Verlag, Heidelberger Platz 3, D-1000 Berlin 33, Federal Republic of Germany.



Managing Editors

Ph. E. Greenman, East Lansing, USA
U. Moritz, Lund, Sweden

Coordinating Editors

H. Baumgartner, Zurich, Switzerland
J. Dvorak, Zurich, Switzerland

Co-Editors

J. Dexter, Columbia, USA
J. Ebbetts, London, UK
J. W. Fisk, Hamilton, New Zealand
S. Haldeman, Santa Ana, USA
V. Janda, Prague, CSSR
H.-D. Neumann, Bühl, FRG
G. W. Northup, Mesa, USA
D. G. Simons, Huntington Beach, USA
C. R. Winer, Sydney, Australia
B. Wyke, London, UK

Advisory Board

H. Biermann, Ibbenbüren, FRG
H. Brodin, Stockholm, Sweden
I. Colombo, Milan, Italy
J. Fossgreen, Aarhus, Denmark
M. Hülse, Mannheim, FRG
K. Lewit, Prague, CSSR
R. Maigne, Paris, France
A. de Poorter, Brugge, Belgium
E. Schwarz, Novaggio, Switzerland
H. Tilscher, Vienna, Austria

Springer  International



We are grateful to the British Institute and Society of Orthopaedic Medicine for the following book review reprinted from The Journal of Orthopaedic Medicine. The reviewer, Dr. Alan Stoddard, is well-known to A.A.M.M. members as an authority on the subject.

Spinal Manipulation

by J F Bourdillon & A E Day

Fourth Edition Published by Heinemann Medical 1987
250 pages £24.95 in UK

I read the first edition of this book 17 years ago with keen interest because I knew John Bourdillon and was surprised and delighted that he should choose to give up his occupation as an orthopaedic surgeon of many years standing, to become a manipulative surgeon. For 20 years now he has been using manipulation as the keystone of his practice and has gained a worldwide reputation, particularly in Canada and the United States. His collaboration with Dr A E Day in the 4th Edition is another step forward for the recognition which manipulation deserves within the ambit of medicine. Dr Day is a Fellow of the Royal College of Physicians in Canada and a specialist in Physical Medicine and Rehabilitation.

When two such eminent doctors join together to write a book on Spinal Manipulation, it is an event of outstanding importance, not only because the book is so well written and illustrated but because their qualifications in orthodox medicine and surgery lend additional weight to their arguments in favour of spinal manipulation. Such men would not spend most of their time using manipulation if they had not studied the subject fully and found it had great merit.

Their references at the end of each chapter show how wide their reading has been. Virtually every book and article on the subject for the last 50 years is mentioned, including my own. It is pleasing too that they do not circumscribe the term 'manipulation' too much, and use the term in the wide North American sense. Due credit is given to the early manipulators, viz: the osteopaths. The chief features of a spinal manipulable lesion are loss of mobility, alteration of local muscle tone and tenderness. They call this entity joint dysfunction. The osteopaths call it somatic dysfunction, to have an even wider impact. However, there is basic agreement between their concept of the spinal lesion and the osteopath's current concept. The writers do not dwell on the effects of spinal lesions on the autonomic nervous system, but they do agree (on p 238) that spinal lesions can influence the autonomics sometimes.

Comparing the first edition, almost a pocket book, with the new edition, the 4th Edition is greatly expanded and can be regarded as a full dissertation on the subject from which any reader interested can gain great insight and knowledge. It is notoriously difficult to set down in the written word, the practical steps needed to achieve effective manipulation, but the illustrations help greatly in this respect. A new reader, ie new to the idea of using manipulation for spinal problems, might be daunted by the details of techniques both in examination and manoeuvres, but they should not be deterred. To acquire skills in manipulation takes time and application - preferably under supervision from other experienced manipulators. The rewards of success when manipulation is expertly applied on the right patient and for the right reasons are so worthwhile, that it easily compensates for the effort needed to acquire the skills. There is an apt analogy for beginners who have difficulty with palpation, by comparing the difficulty of a beginner in reading Braille yet many blind people can read Braille rapidly just by touch.

Manipulation in its wide sense does not merely cover specific thrusting techniques, but also articulatory or mobilising techniques and muscle energy techniques. Suitable emphasis is indicated for these methods.

There are many commendable views on controversial subjects, ie: physiological movements of the spine; the importance of reflex muscle tone in maintenance of spinal lesions; the need for using gentle muscle energy techniques, especially with patients who are ill and in too much spasm; disadvantages of traction; the use of locking; long leverage

techniques; functional X-rays advocated; occipito-atlantal lesions and contra indications; emphasis on sacro-iliac lesions; trigger points; epidural injections.

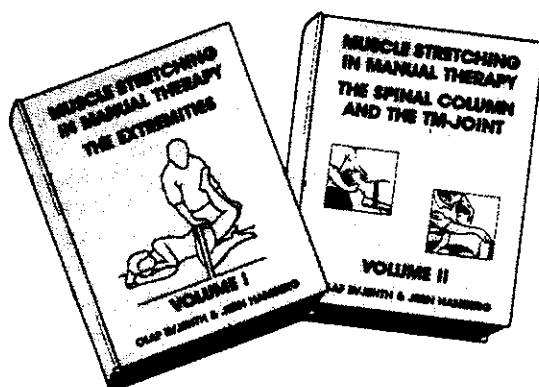
There are some disappointments, however, in the dismissal of hypermobility as being fairly unimportant; little reference is made to Scheuermann's osteochondrosis which after all is the cause of most thoraco-lumbar lesions; and the conclusion made on p 229 that 'the sacro-iliac joint appears to be the single greatest cause of back pain'. This is difficult to accept even by one who has been manipulating sacro-iliac joints for 50 years!

The last chapter on 'The Validation of Manipulation' does not go into detail about the many clinical trials used to demonstrate the value of manipulation, but the authors point out that a key factor in any future trials should be the skill of the operator.

The fact that the book is now in its 4th Edition proves its popularity. The new edition is even better and any reader will find it invaluable.

Alan Stoddard
MB BS MRO DPhys Med

NOW AVAILABLE



MUSCLE STRETCHING IN MANUAL THERAPY A CLINICAL MANUAL

By Olaf Evjenth & Jern Hamberg

VOLUME I The Extremities
VOLUME II The Spinal Column and the TM-Joint

A comprehensive text on muscle stretching for the spine and extremities. Beautifully illustrated with over 500 colour photographs. Highly recommended to all practitioners of musculoskeletal medicine.

Also available:

- * Sequence Exercise book by Gunnari, Evjenth and Brady.
- * Mobilisation of the Extremity Joints book by Kaltenborn.
- * Belts, wedges, etc. for manual therapy.
- * Flexible plastic spine models.
- * Flexible plastic joint models.
- * Fully articulated plastic skeletons.
- * Other anatomic models.
- * Anatomic wall charts.
- * Masolet treatment tables.

Please send copies of Volume I @ \$90.00
..... copies of Volume II @ \$90.00
..... copies of Sequence Exercise @ \$18.00 each

NAME

ADDRESS

.....Postcode

Please forward order to:
Mr. B.W. Atkinson,
33 King Street,
Rockdale. 2216

All orders prepaid.
Add \$3.50 for postage and
handling in N.S.W.
Interstate \$5.00

STATISTICAL VALIDATION OF MANIPULATIVE THERAPY FOR THE TREATMENT OF SEVERE MUSCLE WASTING

An intense search of the world literature has revealed hitherto unrecognised evidence of the effect of a simple manipulative regime on the severe muscle wasting associated with advanced malnutrition.

The paper also seems to provide further proof of the close relationship between musculoskeletal and visceral dysfunction, with implications of significance to all those interested in the fields of food allergy avoidance and nutritional reflexology.



Fig. 41.— from a photograph. Shows the condition of the patient before Dr. Playfair began to treat him with massage.



Fig. 42. — from a photograph. Shows the patient's condition after eight weeks of massage and feeding..

Although the series reported contained only one patient, that patient was randomly selected for the study. The trial was double-blind (in the patient's case due to severe avitaminosis A and in the practitioner's case due to total ignorance of possible outcomes of such an experiment).

Statistical analysis of the results revealed most impressive evidence of benefit during the treatment period. The regime was deemed to be 100% successful.

Considerable interest is now being shown in the work by numerous bodies including the World Health Organisation, which feels that the regime may have application in the famine areas of Africa, and the International Federation of Clinical Psychiatrists, which has stated that the report may signify a breakthrough in the treatment of anorexia nervosa.

Members are encouraged to study the report, not only for its therapeutic interest but to see how easily simple clinical research can be used to add weight to one's curriculum vitae.

ADVERTISERS' INDEX

Atkinson	59
Ciba-Geigy	5, 26, 30, 31
Manual Medicine	57
McKenzie Aids	2
Squibb	IFC

SOUTH COAST - MOLLYMOOK

2½ hours from Sydney

WANTED: Doctor to join 3 solo GP's soon to be amalgamated into one group in a MEDICAL CENTRE. The Dr to have equal share in the LAND & BUILDINGS; also in the RENT from X-RAY, PATHOLOGIST & CHEMIST.
REPLY: Dr. Herbie Chee (044) 55 2612 (H), (044) 55 2235 (S)

See you at ...

**The 18th Annual Scientific Meeting
of the**

Australian Association of Musculoskeletal Medicine

to be held in

Newcastle, N.S.W.

on

2nd - 4th December, 1988

Theme: "Injections in Musculoskeletal Medicine"

