Lumbar Spine Surgery

Indications, Techniques, Failures and Alternatives

Edited by

Joseph C. Cauthen, M.D.

Lumbar Spine Surgery

Indications, Techniques, Failures and Alternatives

Edited by

Joseph C. Cauthen, M.D.

Staff Neurosurgeon
North Florida Regional Hospital and Alachua General Hospital
Gainesville, Florida

WILLIAMS & WILKINS
Baltimore/London

Made in the United States of America

Library of Congress Cataloging in Publication Data

Main entry under title:

Lumbar spine surgery.

A revision of papers which were originally presented in the Lumbar Spine Surgery Seminar in Gainesville, Fla. in 1980.
Includes index.
Contents: Lumbar pain/Joseph C. Cauthen—Lumbar spondylosis and stenosis/W. H. Kirkaldy-Willis—High resolution computed tomography of the lumbar spine/by Kenneth B. Heithoff—[etc.]
1. Intervertebral disk—Surgery—Congresses. 2. Vertebrae, Lumbar—Surgery—Congresses. 3. Backache—Surgery—Congresses. I. Cauthen, Joseph C. [DNLM: 1. Intervertebral disk—Congresses. 2. Lumbar verterbrae—Surgery—Congresses. 3. Spinal diseases—Congresses.
WE 750 L957 1980
RD771.I6L856 1983 617'.56 82-11195
ISBN 0-683-01500-1

Composed and printed at the
Waverly Press, Inc.
Mt. Royal and Guilford Aves.
Baltimore, MD 21202, U.S.A.

Lumbar Spine Surgery

Indications, Techniques, Failures and Alternatives

This volume is dedicated to
Frances, Fran, and Joseph, and to my parents.
Their love and support made it possible.

Foreword

This volume is a revised, updated, and edited record of the proceedings of a symposium presented to a live and participating audience. The subject matter was limited to the surgical management of disorders of the lumbar discs and joints other than fractures or fracture dislocations. Each of the faculty was asked to deal with limited special segments of this limited problem. Moreover, the reader is necessarily deprived of the benefits of interfaculty debate which followed each presentation and which was, no doubt, zestful.

Concern that these limitations might project the faculty in a more partisan role than their eminent records so thoroughly justify has led the editor to invite me to write a foreword.

The papers are well written; they are stimulating, provocative, and informative. They will serve as a valuable reference for experienced spine surgeons. Yet, I must add that I do not find myself in agreement with all that has been said.

My experience, for example, indicates that psychosocial problems play a very important role in patient selection. Spondylosis is often a coincidental finding in patients disabled with low back and leg pain due to systemic and, at times, reversible disorders.

Computerized tomography has added greatly to the diagnosis of changes in the spinal canal and in the root canals. It does not, however, determine when the changes are responsible for disabling symptoms.

Gowers, in 1888, observed that spondylosis would offer a fertile field for the surgeon. The valuable experiences described here indicate that cultivation of the field is still under way.

It is exciting to me to note that in the multidiscipline approach to the problem of the lame back, the era of the spinal surgeon appears to be at hand.

FRANK H. MAYFIELD, M.D., F.A.C.S.
Mayfield Neurological Institute
of Cincinnati
Cincinnati, Ohio

Preface

This text offers a collection of chapters dealing with current topics in the field of lumbar degenerative disc disease. An attempt has been made to present a sequence favoring continuity, but each author has been encouraged to present his efforts so that his chapter could stand alone. The chapters were originally presented in the Lumbar Spine Surgery Seminar in Gainesville, Florida, in 1980, and considerable revision has been required as the field advanced in the intervening months. Analysis of the reasons for surgical failures and alternatives to surgery are included for the reader's consideration. The collective goal of the contributors is to reduce the chance for error in patient selection, in diagnosis, and in surgical technique.

Acknowledgments

The concepts put forth in this text are the products of many years of careful study by the authors and by their teachers of anatomy, physiology, pathology, and surgery. These few words of recognition are a meager tribute to those pioneers who have shown the way to discoveries elucidated in these pages. The greater tribute will come from patients whose lives may be improved by these efforts.

Special thanks are extended to Sandra Sharon, Elizabeth Fannin, Carolyn Nutting, and Hazel Sessions for their parts in the preparation of the manuscript.

Alice Reid, Editor, and the staff of Williams & Wilkins have been invaluable in their support and encouragement.

The support of the Directors of the North Florida Regional Medical Foundation is gratefully acknowledged.

Contributors

CHARLES V. BURTON, M.D., F.A.C.S.
(*Chapters 11 and 12*)
Director, The Low Back Pain Clinic
Sister Kenny Institute
Minneapolis, Minnesota

JOSEPH C. CAUTHEN, M.D., F.A.C.S.
(*Chapter 1*)
Staff Neurosurgeon
North Florida Regional Hospital and Alachua General Hospital
Gainesville, Florida

BERNARD E. FINNESON, M.D., F.A.C.S.
(*Chapter 4*)
Chief, Department of Neurosurgery
Crozer-Chester Medical Center
Chester, Pennsylvania

KENNETH B. HEITHOFF, M.D.
(*Chapter 3*)
Department of Radiology
Abbott-Northwestern Hospital Corporation
Minneapolis, Minnesota

WILLIAM H. KIRKALDY-WILLIS, M.D., F.R.C.S.
(*Chapter 2*)
Professor of Orthopaedics
University Hospital
University of Saskatchewan
Saskatoon, Saskatchewan Canada

PAUL M. LIN, M.D., F.A.C.S.
(*Chapter 7*)
Clinical Associate Professor of Neurosurgery
Temple University School of Medicine
Philadelphia, Pennsylvania

ARTHUR A. MAUCERI, M.D.
(*Chapter 10*)
Internist, Consultant in Infectious Disease
North Florida Regional Hospital
Gainesville, Florida

HUBERT L. ROSOMOFF, M.D., F.A.C.S.
(*Chapter 6*)
Professor and Chairman
Department of Neurological Surgery
University of Miami School of Medicine
Miami, Florida

J. CARL SUTTON, M.D., C.M., F.R.C.S. (C)
(*Chapter 9*)
Orthopaedic Surgery
Montreal, Quebec, Canada

ROBERT WARREN WILLIAMS, M.D., F.A.C.S.
(*Chapter 5*)
Chief, Department of Neurosurgery
Sunrise Hospital
Las Vegas, Nevada

LEON L. WILTSE, M.D., F.A.C.S.
(*Chapter 8*)
Clinical Professor of Orthopedic Surgery
University of California Medical School
Irvine, California

Contents

1

Lumbar Pain—An Overview

INTRODUCTION

The impetus for writing this chapter and indeed, for encouraging the assembly of the material in this book has emerged from 20 years of dealing with patients with lumbar pain secondary to degenerative disc disease.

As a house officer in a neurosurgical training program, later a faculty member, and now as practitioner, I have been impressed with the simple fact that the majority of patients with lumbar pain radiating into the legs are suffering from pathologic changes involving the spinal nerves. Very few patients with low back pain, and almost none with accompanying leg pain, have a neurotic basis for their complaints, although many may be depressed as a consequence of their suffering. The incidence of patients seeking secondary gain is significant, but their symptoms are readily identified and the lack of supporting evidence for pathologic changes can be documented by the newer diagnostic methods described in this text.

THE DYNASTY OF THE DISC

There seem to be two firmly entrenched axioms ruling the operative approach to patients with lumbar pain radiating to the lower extremities: (1) always operate upon a patient with an extruded disc fragment if symptoms are considered related to the fragment, and (2) never operate upon a patient with a normal myelogram, even if symptoms appear to be localizing.

These axioms are in full consonance with the dogma of the Dynasty of the Disc recently articulated and denounced by MacNab.[1] This thinking holds that all, or nearly all, lumbar pain radiating to the legs is related to dislocation of the lumbar intervertebral disc against the lumbar nerves. Exceptions are made for congenital, infectious, or neoplastic etiologies, of course. The first axiom is widely known and fully reliable. The second axiom has been soundly disproven with evidence that subarticular nerve entrapment beneath enlarged facets often exists in the presence of a normal myelogram and is a common cause of lumbar pain radiating to the legs.[2]

The era of the Dynasty of the Disc has been drawing to a close, coincident with the widening recognition that lumbar nerve compression may be secondary to degenerative joint changes, not just disc hernia. Ehni's authoritative review[3] of the historical development of modern concepts of lumbar nerve compression is of great interest in this regard.

DIAGNOSTIC CONSIDERATIONS

We have entered an era in which the practitioner treating lumbar degenerative disc disease is compelled to consider numerous interrelated causes of lumbar pain and associated leg pain, including lumbar disc hernia, lumbar disc protrusion, extrusion, and sequestration, central canal stenosis, lateral bony entrapment, developmental, traumatic, pathologic, and degenerative spondylolisthesis, and lumbar instability.

Epstein's landmark contribution in 1960[4] and his more recent review supply definitions of great usefulness and clarity. We are reminded that nerve compression associated with disc hernia can be reliably predicted by a positive straight leg raising test,

but this finding, and reflex and sensory deficits are less likely to be present in subarticular entrapment.[5] Central canal stenosis usually causes back and leg pain with enough variability so as to seem related to anxiety or to vascular insufficiency, but the cardinal features of neurogenic claudication are characteristic—paresthesia and hypesthesia after exertion, followed by weakness in the legs, relieved by rest or spine flexion. Lumbar instability can be predicted by the presence of pain on weight bearing or axial loading, relieved by unloading or bed rest, and by x-ray findings of traction spur, abnormal flexion-extension mobility, disc space narrowing, and facet subluxation.[6]

As indicated by the contributing authors in this text, high resolution computed tomography (CT) will often prove invaluable when the cause of symptoms is not clear, despite adequate myelography. An impression is emerging that further technological advances in CT scanning will eventually make myelography obsolete. If screening capabilities rivaling myelography are available, this will be quite desirable as an alternative. As this improved diagnostic state of the art is approached, few patients will be relegated to the category of "low back pain of unknown cause," and the erroneous concept that disc hernia is the only cause of back and leg pain will be discarded.

PRINCIPLES OF TREATMENT

Having proceeded to the point where an active search for the causes of pain is initiated, one should ultimately come to a conclusion that nerve compression is present or not and that the spine is stable or not. The patient with no objective evidence for nerve compression or instability will eventually recover from low back pain, aided by anti-inflammatory drugs, gentle exercises, and reassurance. Recurrences will occur and should be anticipated.

The natural history of an unstable spine suggests that fusion is not always necessary, as indicated by Kirkaldy-Willis in Chapter 2. Normal restabilization, in his view, occurs reasonably often. This opinion is shared by Goldner[7] in his observations on the role of fusion in unstable spinal segments. Burton et al.[8] have also suggested that dorsolateral fusion may have less application in degenerative disc disease. When instability is present, and symptoms are unrelenting, several options for fusion are available, as indicated by Wiltse (Chapter 8) and Lin (Chapter 7).

Decision-making for patient selection is improved by consideration of pertinent physical and emotional findings, as outlined by Finneson in Chapter 4. It is axiomatic that proper selection will lead to improved surgical results and fewer numbers of failed back surgery patients.

In the difficult question of selection of the proper level for surgical exploration, Rothman[9] recommends utilization of the following priorities:

(1) metrizamide myelography;
(2) neurological deficits;
(3) pain distribution;
(4) straight leg raising test;
(5) x-ray findings;
(6) discogram.

Routine x-rays, while valuable in proving existence of congenital abnormalities, tumor, or infection, have not detracted from or supported the determination of the presence of lumbar disc hernia. Similarly, lumbar discography is considered too sensitive and the resultant findings too widespread through a normal population to be of value in this regard, according to Rothman.[9]

In those clinical situations where the cause of lumbar pain remains obscure despite adequate myelography, CT scanning may be helpful in determining the proper level for exploration. Further, many advocates of lumbar discography believe that films made following direct injection of contrast material into the disc yields invaluable information, as shown by Shapiro,[10] Collis,[11] and Cloward.[12] After specific criteria for selection of the patient and the operative level are applied, it is essential that the procedure be done with *technique appro-*

priate for handling nerve tissue. Basic requirements include a dry operative field and absence of iatrogenic nerve compression or contusion. While easy to describe, these goals are not easy to accomplish. The use of a fiber optic headlight and 2–2.5 power wide-field loupes is invaluable in this regard. The writer's preference is to use the operating microscope with 300-mm lens for that portion of the procedure where nerve dissection is required or when disc material is removed for nerve decompression.

As advocated by Williams in Chapter 5, the adequacy of the procedure can be better assessed if illumination is optimal, vessels are protected, and structures are magnified. On numerous occasions, the author has taken a final look with the operating microscope only to discover small retained fragments of disc, remnants of the ligamentum flavum, or facet edge which one would assume would have created problems.

RESULTS OF TREATMENT

In an attempt at evaluation of results of micro-operative technique in nerve decompression procedures, the author reviewed his own experience as to outcome in 175 consecutive patients undergoing operations for initial lumbar disc hernia with associated nerve compression. All of the patients were followed 1–5 years before a determination was made. Results are based on Finneson's patient self-evaluation criteria (Chapter 4) and statements made to the author in follow-up visits. All procedures were completed with careful attention being given to short incisions, thorough hemostasis, optimal illumination and magnification, and complete removal of disc fragments. When necessary, medial facet edges were resected to allow ease of access to the intervertebral space, or to discover and remove medially placed or central herniations. End-plate curettage was avoided, but vigorous attempts at removal of disc material from the posterolateral quadrant and the disc center were routinely carried out.

In this operative series, results were classified by the author as satisfactory or unsatisfactory using self-evaluation forms in 142 instances and statements made to the author in 33 additional cases in which questionnaires were not returned. Satisfactory results included patients who returned to occupations not requiring significant lumbar exertional stress and housewives who had reduced or modified activity levels but were functioning without medication on a recurrent basis.

Results rated as unsatisfactory included those who reported no particular benefit from surgery, those requiring non-narcotic analgesic medications and those who could not return to work on account of pain.

	Satisfactory	Unsatisfactory
Patients	161	14
Percent	92	8

Four patients, self-evaluated as unsatisfactory after the initial procedure, have undergone a second exploration with removal of additional persistent or recurrent fragments. After 1 year of follow-up these patients now rate themselves as having a satisfactory result. This change favorably affects the overall percentage of patients expressing satisfaction (94%). Longer follow-up no doubt will show a degradation of these figures as the progress of degenerative disc disease continues, but initial results compare favorably with those reported by Williams,[13] Wilson,[14] and Goald.[15] It is the author's opinion that improved patient selection and micro-operative technique have been responsible for improved results.

The technique of nerve decompression by medial facetectomy or facet undercutting deserves more emphasis as one considers additional causes for lumbar pain radiating to the legs. The now familiar subarticular nerve entrapment can be alleviated by careful removal of the medial one-third of the superior and inferior facets with a

small osteotome, sonic-powered curette or angled Kerrison rongeur. Patency of the foramen and lateral nerve canal can be proved by inspection and passage of a right-angled probe beneath the superior facet and through the foramen, as advocated by Kirkaldy-Willis in Chapter 2 and Burton in Chapter 12. The exposed dura should be covered with an autologous fat graft to retard the ingrowth of fibroblasts and reduce the incidence of epidural adhesions, as described by Langenskiold and Kiviluoto,[10] Mayfield,[11] and as strongly advocated by Burton in Chapter 12 of this text.

The findings of Burton and Kirkaldy-Willis regarding the causes of failed back surgery syndrome are of great importance. The observation that 50–60% of a population of patients with failed back surgery syndrome had unrecognized, untreated lateral spinal stenosis deserves careful attention, and should prompt re-evaluation of patients with continuing difficulties related to degenerative disc disease.

CONCLUSION

Recent advancements in theory and practice have led to a realization that disc hernia is not the only cause of lumbar pain radiating to the legs and that stenosis of the central canal and lateral recesses is of equal etiologic importance. Accurate diagnosis requires high quality water-soluble contrast myelography. In those cases where this is not helpful, high-resolution CT may delineate subarticular nerve entrapment and nonapparent lateral disc hernias.

Improved results are dependent on careful patient selection, superior diagnostic methodology, and operative technique appropriate for handling nerve tissue.

References

1. MacNab, I.: Nerve Root Compression Syndromes, Presented at Hilton Head Island Neurosurgical Symposium, August, 1980.
2. MacNab, I.: Negative disc explorations. An analysis of nerve root involvement in sixty-eight patients. *J. Bone Joint Surg. 43A:*891–903, 1971.
3. Ehni, G.: Historical writings on spondylotic caudal radiculopathy and its effects on the nervous system. In *Lumbar Spondylosis*, edited by P. R. Weinstein, G. Ehni, C. B. Wilson, pp. 1–12, Chicago, IL, Year Book Medical Publishers, 1977.
4. Epstein, J. A.: Diagnosis and treatment of painful neurological disorders caused by spondylosis of the lumbar spine. *J. Neurosurg. 17:*991, 1960.
5. Epstein, J. A.: The role of spinal fusion, Question 2. *Spine 6(3):*281–283, May–June, 1981.
6. Frymoyer, J. W.: The role of spinal fusion, Question 3. *Spine 6(3):*289, May–June, 1981.
7. Goldner, J. L.: The role of spinal fusion, Question 6. *Spine 6(3):*293, May–June, 1981.
8. Burton, C. V., Heithoff, K. B., Kirkaldy-Willis, W., Ray, D. D.: Computed tomographic scanning in the lumbar spine, Part 2: Clinical considerations. *Spine 4(4):*379–390, July–Aug., 1979.
9. Rothman, R. H.: The role of spinal fusion, Question 1. *Spine 6(3):*279–281, May–June, 1981.
10. Shapiro, R., Galloway, S. J., Goodrich, I.: The evaluation of the patient with a negative or indeterminant myelogram. *Radiographic Evaluation of The Spine*, edited by J. D. Post, pp. 603–608, New York, Masson Publishing USA, Inc., 1980.
11. Collis, J. S., Jr.: *Lumbar Discography*, Springfield, Ill., C C Thomas, 1962.
12. Cloward, R. B., Buzaid, L. L.: Discography: technique indication and evaluation of the normal and abnormal intervertebral disc. *Amer. J. Roentgen. 68:*552, 1952.
13. Williams, R. W.: Microsurgical and standard removal of the protruded lumbar disc: a comparative study: comments. *Neurosurgery 8(2):*422, 1981.
14. Wilson, D. H., Kenning, J.: Microsurgical lumbar discectomy: preliminary report of 83 consecutive cases. *Neurosurgery 4:*137, 1979.
15. Goald, H. J.: Microlumbar discectomy: follow-up on 147 patients. *Spine 3(2):*183, 1978.
16. Langenskiold, A., Kiviluoto, O.: Prevention of epidural scar formation after operations on the lumbar spine by means of free fat transplants. *Clin. Orthop. 115:*92–95, 1976.
17. Mayfield, F. H.: Autologous fat transplants for the protection and repair of the spinal dura. *Clin. Neurosurg. 27:*Chapter 19, 349–361, 1979.
18. Burton, C. V.: The role of spinal fusion, Question 4. *Spine 6(3):*291, May–June, 1981.

2

Lumbar Spondylosis and Stenosis

In this chapter, the nature of the degenerative process is presented. Application of this knowledge to diagnosis and treatment follows.

PATHOLOGY

The L4–5 and L5-S1 levels are the most commonly affected areas. Later, the original lesion spreads to involve the whole of the lumbar spine. Farfan[1] has emphasized the importance of the concept of the "three-joint complex" of two posterior joints and disc at each level. Changes affecting one also affect the other and vice versa. The alignment of the posterior joints at the lowest two levels permits more rotation than at higher levels. Recurrent minor rotational strains of posterior joint capsule and annulus fibrosis are the most common causes of the development of degenerative changes in these structures and in the joints. Compressive injuries, often apparently minor in extent, can cause fractures of the cartilage plates of the disc. This is initially followed by slow degenerative changes in the disc and later, by posterior joint changes (Fig. 2.1).

The Posterior Joints

The sequence of change is similar to that seen in any synovial joint: synovitis, synovial tags in the joint, adhesions between the joint surfaces, capsular tears, degeneration of articular cartilage, the formation of osteophytes, and fractures of a lamina near the joint. This may produce a permanent rotational deformity. Increasing capsular laxity allows an increase of laxity of the joint and this is followed by an increase in abnormal movement of the joint (Figs. 2.2 and 2.3).[2]

The Intervertebral Disc

As a result of repeated minor trauma, tears are produced in the annulus. The earliest of these are circumferential. As these enlarge and coalesce, radial tears are formed. Later, an enlargement of the tears leads to internal disruption of the disc. The interior of the disc at this stage is completely disrupted by a large tear that extends from front to back and side to side. There is loss of disc height and the annulus bulges outwards around the whole circumference. From this point on, there is further disintegration of the disc with progressive increasing loss of disc height. The opposing vertebral bodies are approximated, the disc is filled by fibrous tissue, and the adjacent vertebral body bone becomes sclerotic. This final stage is called "resorption of the disc" (Figs. 2.4 and 2.5).[2, 3]

Combined Lesions

As stated previously, lesions of one component of the three-joint complex affect the others, and vice versa. Three stages can be recognized in the degenerative process.

Temporary Dysfunction. During this stage, rotational strains traumatize the components of the joint, often producing minor tears. Overlying muscle is in permanent contraction producing a decrease in joint movement. Healing takes place after each episode of trauma but the resultant scar is less strong than normal collagen. With each new incident, healing is less complete and degenerative changes more advanced. The patient enters Stage II.

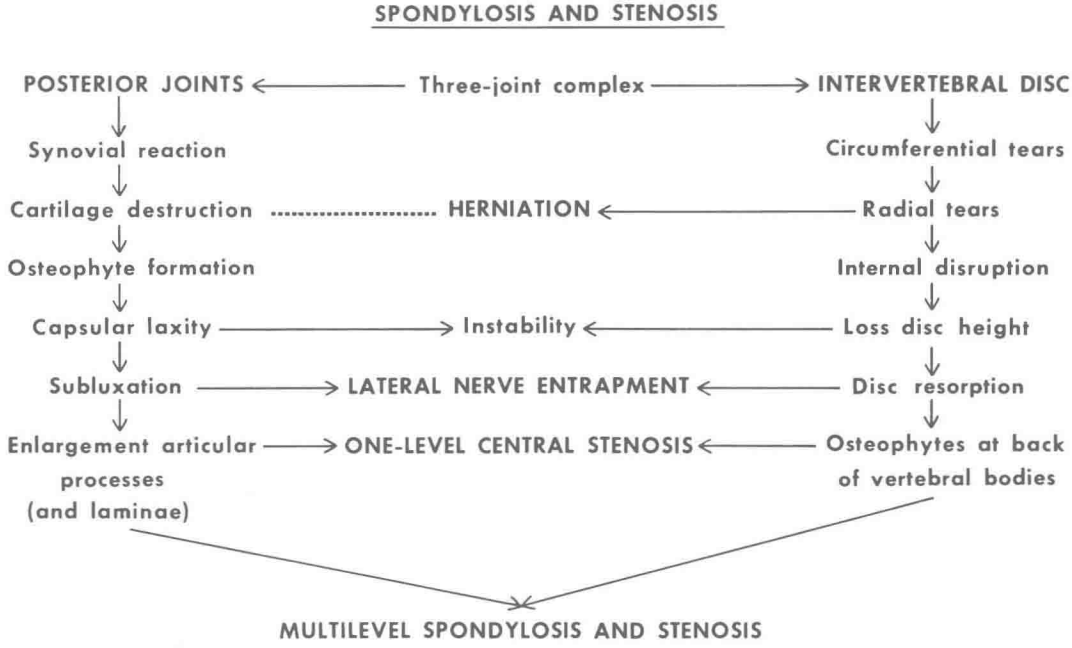

Figure 2.1. The progression of degenerative change in posterior joints and disc with the interaction of the three joint complex.

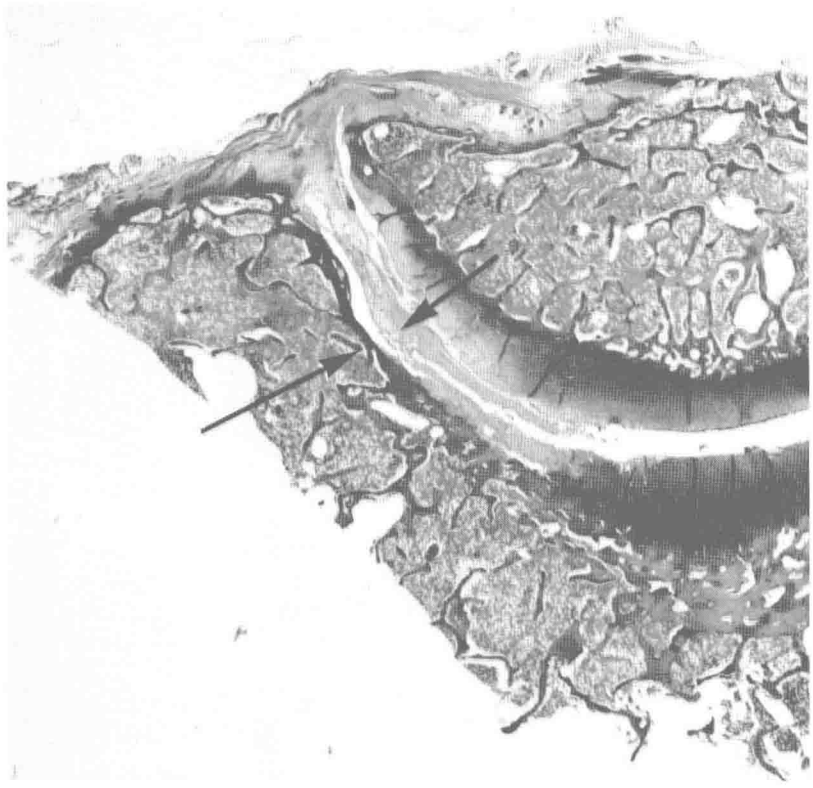

Figure 2.2. Histologic section of a posterior joint. The articular cartilage over the superior facet is eroded (*bottom arrow*). A large fibrous strand lies in the joint between the cartilage surfaces (*top arrow*).

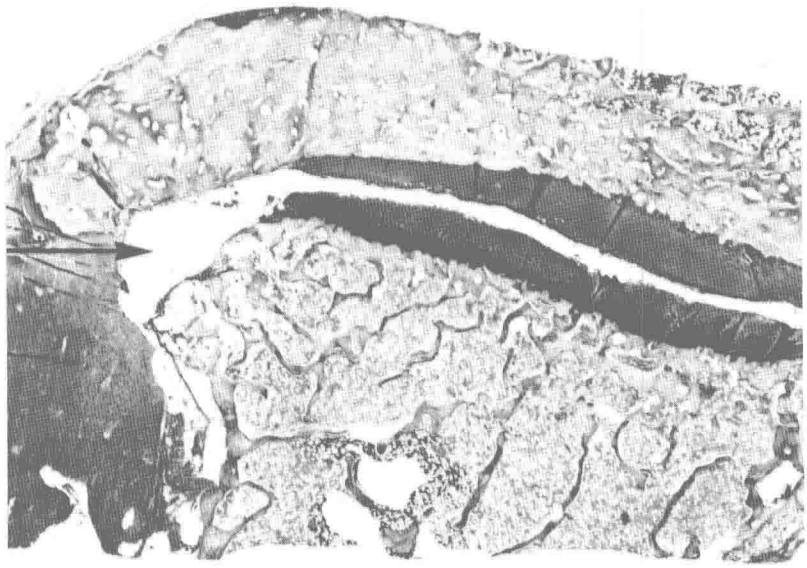

Figure 2.3. Histologic section of a posterior joint. The large clear space to the left of the articular surfaces (*arrow*) is due to capsular laxity—an unstable joint.

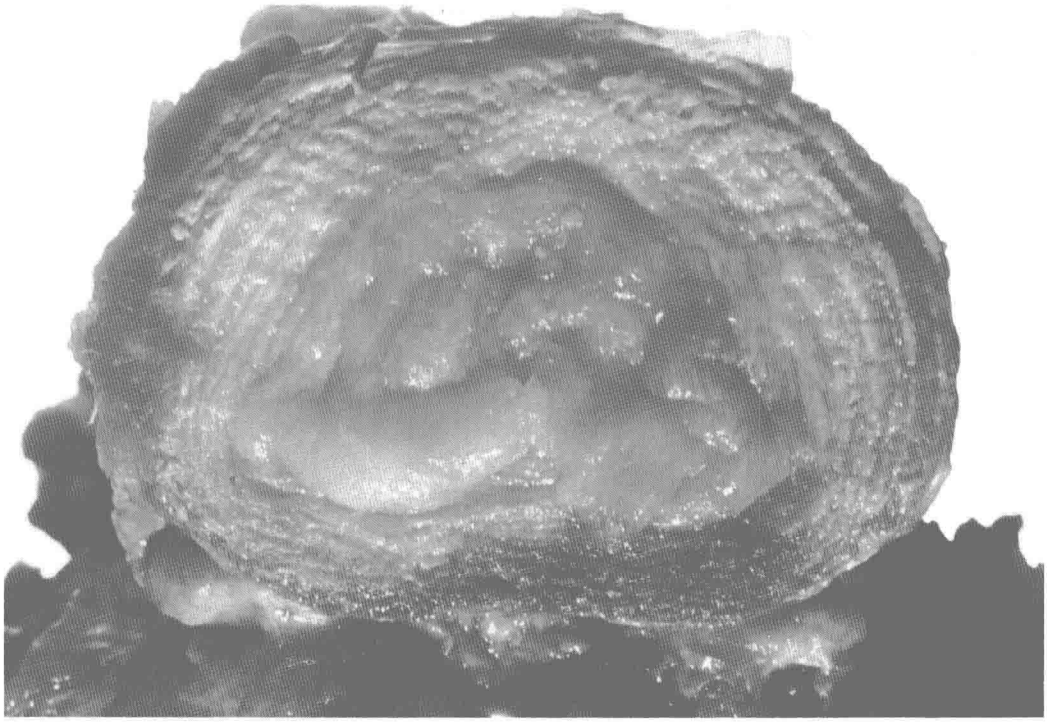

Figure 2.4. Transverse section of intervertebral disc. There are numerous small fissures in the annulus fibrosus. There is early disintegration of the nucleus pulposus.