Prosthetics and Orthotics International, 1982, 6, 139-146

Bracing and supporting of the lumbar spine

S. SCHROEDER, H. RÖSSLER, P. ZIEHE and F. HIGUCHI

Department of Orthopaedic Surgery, University of Bonn, West Germany.

Abstract

The orthopaedic surgeon should be familiar with various supports and braces for the treatment of low back pain. Severe cases of spinal instability always need a Hohmann overbridging brace, whereas the milder form of motion-segment instability is treated with one of the elastic supports. In cases of osteoporosis of the spine and insufficiency of the lumbosacral junction the Lindemann 2/3 semi-elastic brace is prescribed.

Incidence of low back pain

Low back pain affects 80% of all persons during their lifetime. In 70% of the cases the patients recover within 1 month. After 3 months 90% are back to work. Of the remaining 10%, 50% never go back to work (Cailliet 1981).

Orthopaedic diagnoses of low back pain

The term "low back pain syndrome" includes diseases such as lumbosacral strain, facet syndrome, herniated disc, degenerative disc, spinal stenosis, unstable functional unit. Besides these, low back pain can be caused by degeneration and fatigue of the spine and inflammation within the spine (spondylitis). Another cause of pain can be the growth of a tumour.

Anatomy

Knowledge of the anatomy of the motion segment is mandatory to understand the function of the spine. The motion segment consists of an intervertebral disc, its two adjacent vertebral bodies and surrounding ligamentous tissue including the facet joints (Fig. 1). The total spine can be thought of as a motion segment (Kulak et al, 1975). Each vertebra can be divided into an anterior and a posterior element. The dividing line lies behind the posterior border of the body. The anterior elements provide the major support of the column and absorb various impacts. The posterior structures control the pattern of motion.

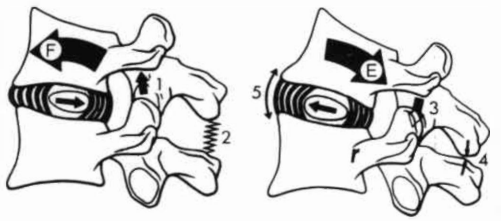

Fig. 1 Flexion (left) and extension (right) of the motion segment. The large arrows indicate nucleus shift (Kapandji, 1974).

Control of trunk motion is performed by different muscle groups. The cross section (Fig. 2) of the abdominal cavity shows that 4/5 of its circumference is made up of abdominal wall muscles. In addition to the trunk motion in the leg lifting position (knees slightly flexed and back straight) lifting is performed mainly by the quadriceps muscles.

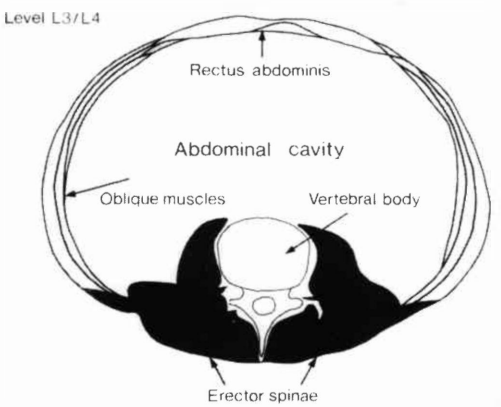

Fig. 2. Cross section of the trunk at level L3/L4.

All correspondence to be addressed to Dr. S. Schroeder, Orthopädische Universitäts Klinik, Sigmund-Freud Str. 25, D5300 Bonn, West Germany.

Origin of back pain

Low back pain can result from stimulation of nerve endings within the spine and its surrounding tissue. Hirsch et al (1963) studied pain receptors and found nerve endings arround the vertebral disc, vertebral periosteum, intervertebral joints and ligaments. The disc itself has no pain receptors.

Degenerative disc disease accounts for 90% of low back pain conditions in an average orthopaedic practice. The other 10% include spondylitis, tumours, deviation of spine axis, malformation of the spine, osteoporosis and other rare diseases.

Therapy

Bracing of the lumbar spine is mostly for degenerative spine disease, which includes disc disease and posterior facet joint disease.

The prescription of a lumbar brace or support is an important part of the therapy for low back pain. According to Perry (1970) only 14 out of 3410 American orthopaedic surgeons had never prescribed some kind of support for low back problems. Before prescription of a spinal support one has to select the type of brace or support and one has to know what a support or brace can do.

Types of braces

Braces can be grouped into two major categories (a) corrective and (b) supportive. Corrective braces such as the Milwaukee and Boston Brace for the treatment of scoliosis will not be discussed. Attention is directed to spinal braces and spinal supports used for treatment of low back pain. In this institution 245 lumbar braces or lumbar supports, mainly for degenerative diseases of the lumbar spine, were prescribed in 1980 (Table 1).

Table 1. Lumbar orthoses prescribed for low back disorders.

Hohmann overbridging brace	19
Lindemann 2/3 semi-elastic brace	24
Bauerfeind nonatrophic lumbar support	99
Tigges lumbar support	103
Total	245

These braces can be divided into the elastic, the semi-elastic and the rigid-elastic support groups. The elastic group includes the Tigges lumbar support (Fig. 4) and Bauerfeind nonatrophic support (Fig. 5), the semi-elastic group includes the Lindemann ⅔ semi-elastic brace (Fig. 6) (Lindemann and Kuhlendahl, 1953). The rigid-elastic group includes the Hohmann overbridging brace (Fig. 7) (Hohmann, 1965).

The efficiency of lumbar supports was studied by Morris et al. (1961). They found that lumbar braces increase the intrabdominal pressure of the wearer at rest by compressing the abdomen and turning the abdomen into a semi-rigid cylinder (Fig. 3).

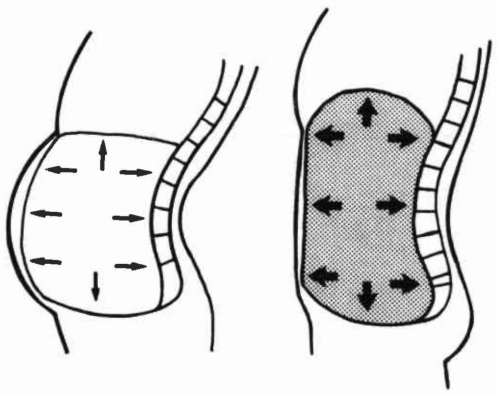

Fig. 3. The abdominal cavity may be considered as a water filled balloon. It can support some of the weight of the upper body if lateral deformation under load can be prevented by containment. The abdominal cavity is shown diagrammatically without lumbar support on the left and with lumbar support on the right (Morris et al, 1961; White and Panjabi, 1978; Radin et al, 1979).

The pressure within the abdominal cavity is believed to influence the load on the spine by supporting the trunk anteriorly. When a support is worn the weight of the upper half of the body rests on the semi-rigid cylinder and not only on the vertebral column. This results in a relief on the weight bearing spine. A lumbar support is constructed to replace the physiological function of the abdominal wall and designed to support the ventral muscles.

Norton and Brown (1957) studied the immobilizing efficiency of low back braces. In particular they examined their effects on the movement of the lumbosacral area and never found total immobilization. The effect of lumbar supports is a reduction of the arc of flexion and extension. Axial rotation and lateral bending is not reduced.

Tigges lumbar support

Function Support of lumbar spine. The immobilizing efficiency is low. The range of movement in the lumbosacral area during flexion and extension is slightly restricted. Supportive effect only below L3/L4.

Effectiveness of control

Axial rotation:	none
Lateral bending:	none
Flexion/extension:	minimal

Pad Flexible, segmental.

Indication Osteochondrosis of lumbar spine. Postoperative after surgery of the low back, slight instability of motion segment, muscle strain.

Cost 200DM.

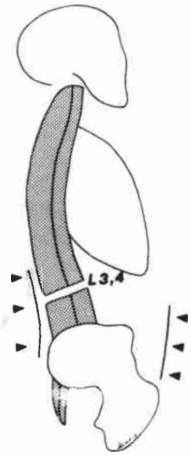

Fig. 4a. Force patterns of the Tigges lumbar support.

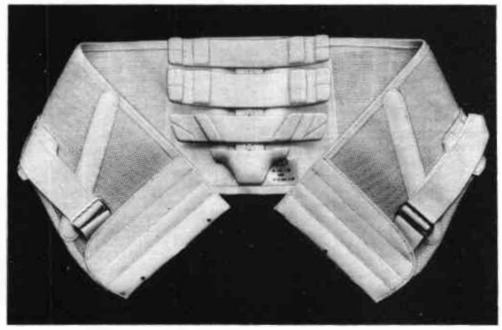

Fig. 4b. The Tigges lumbar support.

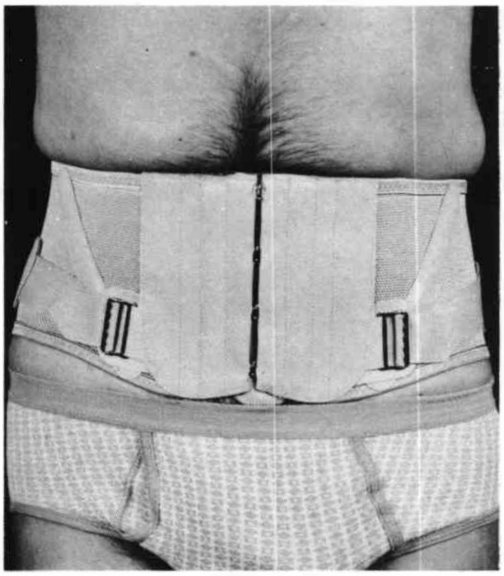

Fig. 4c. Frontal view.

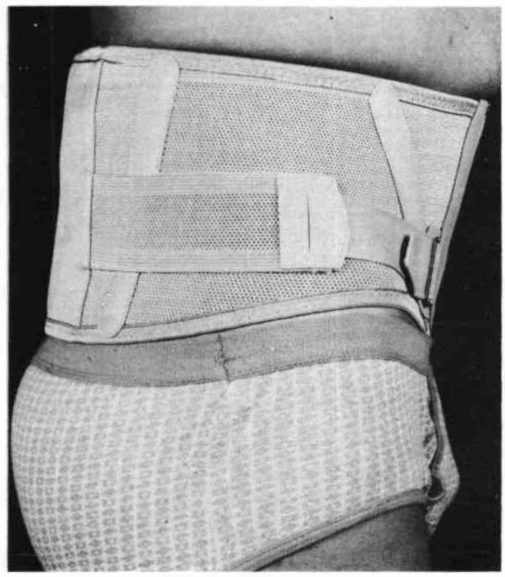

Fig. 4d. Lateral view.

Bauerfeind nonatrophic lumbar support

Function Support of lumbar spine. The immobilizing efficiency is low. The range of movement in the lumbosacral area during flexion and extension is slightly decreased. Supportive effect only below L3/L4.

Effectiveness of control

Axial rotation:	none
Lateral bending:	none
Flexion/extension:	minimal

Pad Semi-rigid covered with silicone.

Indication Osteochondrosis of lumbar spine. Postoperative after surgery of the low back.

Side effect None.

Cost 220DM.

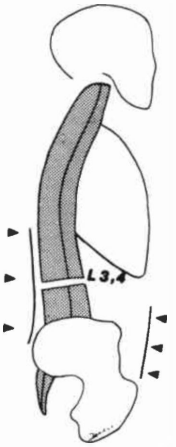

Fig. 5a. Force patterns of the Bauerfeind lumbar support.

Fig. 5b. The Bauerfeind nonatrophic lumbar support.

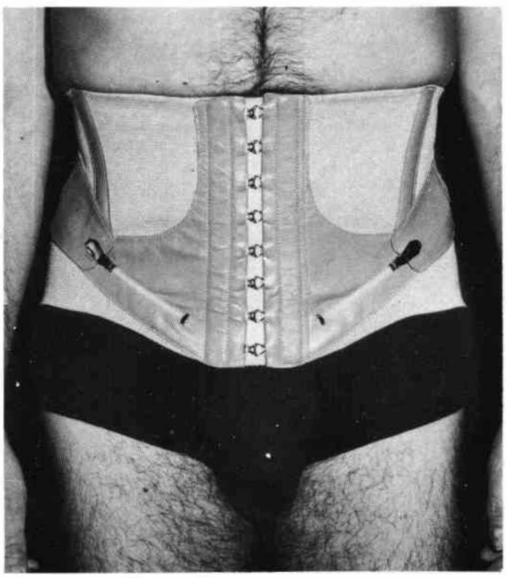

Fig. 5c. Frontal view.

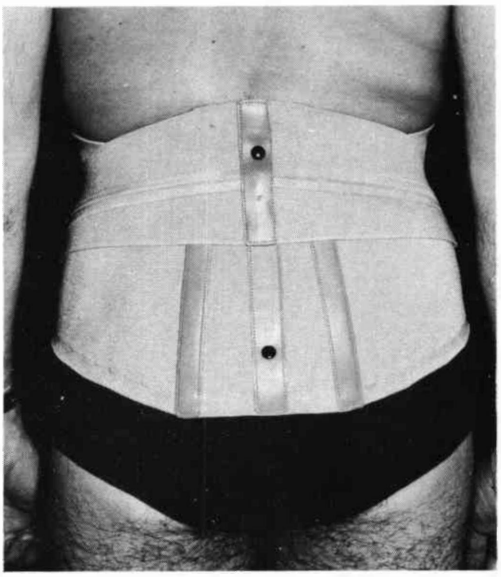

Fig. 5d. Posterior view.

The Lindemann 2/3 semi-elastic brace (Lindemann and Kuhlendahl, 1953; Bayerl and Schubje, 1965; Blomke, 1973).

Function Support of the lumbar spine, decrease of lumbar lordosis. Supportive effect only below T12.

Effectiveness of control

Axial rotation:	minimal
Lateral bending:	minimal
Flexion/extension:	minimal

Indication Insufficiency of back and abdominal wall muscles, slight osteoporosis. Lumbosacral instability.

Side effect Atrophy of back muscles by wearing for a longer time. Physiotherapy necessary.

Cost 200DM.

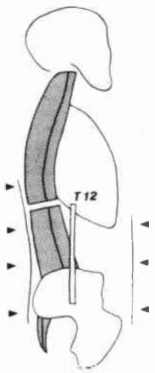

Fig. 6a. Force patterns of the Lindemann ⅔ semi-elastic brace.

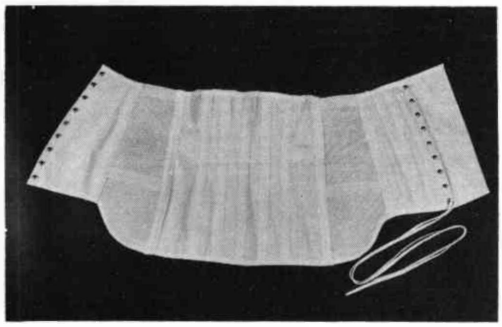

Fig. 6b. The Lindemann brace.

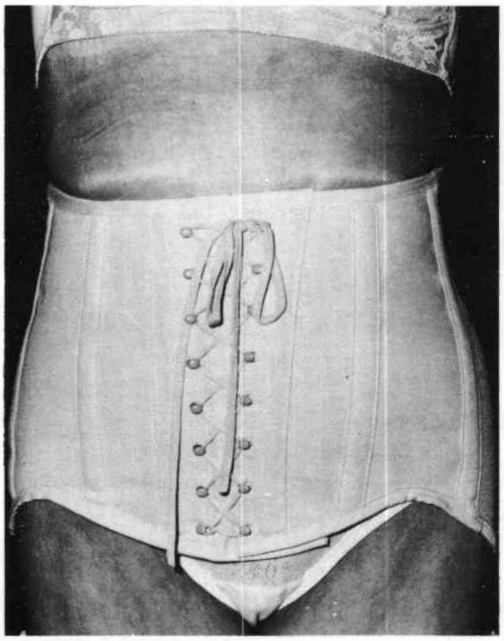

Fig. 6c. Frontal view.

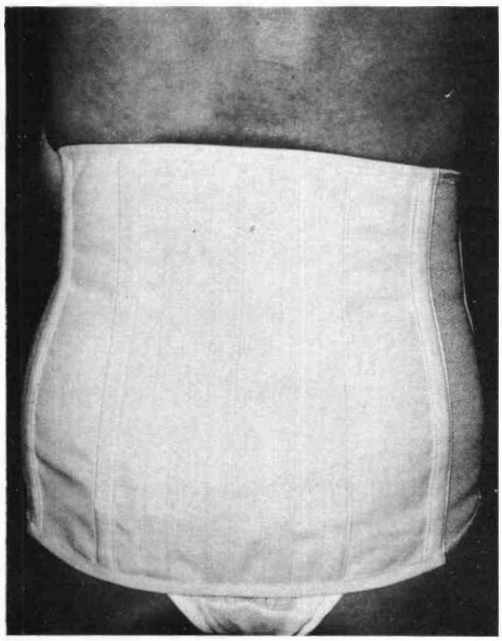

Fig. 6d. Posterior view.

The Hohmann overbridging brace (Hohmann 1965)

Function Support of lumbar spine, decrease of lumbar lordosis. Supportive effect only below L1/L2.

Effectiveness of control (White and Panjabi, 1978).

Axial rotation:	minimal
Lateral bending:	intermediate
Flexion/extension:	intermediate

Indication Severe osteochondrosis of lumbar spine, arthrosis of the facet joints, spondylolisthesis, osteoporosis (severe), lumbar scoliosis in adults. Severe instability of motion segments.

Side effects Atrophy of back muscles possible. Physiotherapy necessary.

Cost 800DM.

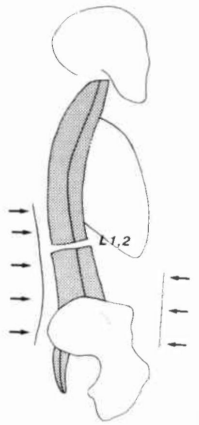

Fig. 7a. Force patterns of the Hohmann brace.

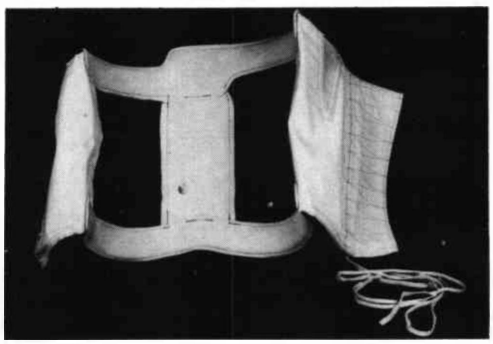

Fig. 7b. The Hohmann overbridging brace.

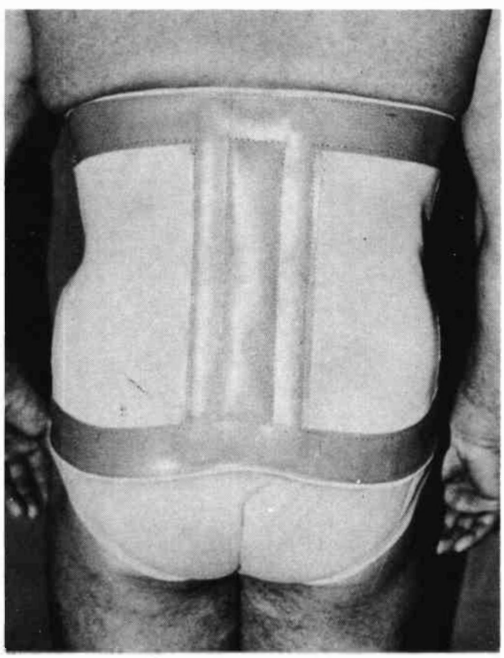

Fig. 7c. Posterior view.

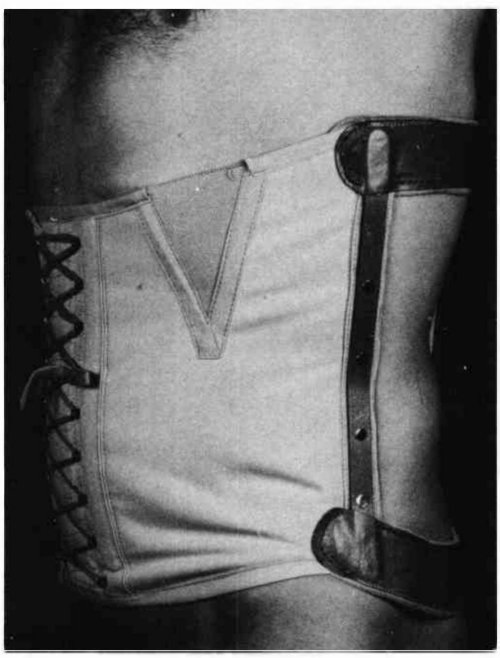

Fig. 7d. Lateral view.

The contribution of back muscles in low back pain

Weak back muscles as a contributory cause of chronic low back pain syndrome have been discussed by many investigators Schede (1966), Nachemson and Lindh (1969). Nachemson pointed out that the strength of the spinal muscles is of doubtful importance for the prevention of back pain, whereas he concluded that the muscle strength of the abdomen can protect the spine. It remains to be clarified whether a weakness is primary or secondary to back pain. It is believed in this Department that well trained muscles, especially abdominal wall muscles, can prevent back pain.

Walters and Morris (1972) studied the electrical activity of the trunk muscles and found no decrease of activity of back muscles and abdominal wall muscles in patients wearing lumbar supports during walking, whereas in standing they found a decrease in EMG activity.

Prescription indications

The purpose of supporting the lumbar spine is to permit ambulation while allowing local rest of the low back. In cases of persistent low back pain due to instability of posterior facet as a result of arthritis four different supports or braces are prescribed (Table 1).

Even when supports are used for acute episodes they sometimes have to be applied for a prolonged time. In these cases physical therapy is given to strengthen the trunk muscles and provide muscular stability. Good results have been obtained by training patients in Back Schools (Forsell, 1981).

The use of supports in cases of acute ruptured discs mostly increases the radicular pain because of increased venous blood flow through the intraspinal canal venous plexus. This can add additional compression to the irritated nerve root. Elastic lumber supports do not immobilize the spine. Extreme flexion and extreme extension is restricted, whereas lateral bending and rotation is unaffected.

Conclusions

A back support can restrict, but not prevent motion in the lower lumbar region. It seems highly unlikely that any device applied to the body can effectively splint the lumbosacral region.

A support produces primarily abdominal compression which transforms the abdominal cavity into a semi-rigid cylinder capable of transmitting stresses through the abdomen rather than through the spine (Morris et al. 1961; Morris, 1974).

Knowing this, the prescription of a low back suport or brace can be helpful in the treatment of low back pain. Many patients obtain symptomatic relief of pain from their use. For sure the relief of pain has also some physiological reasons.

There are many lumbar supports with the same basic construction but called by different names, they differ in the kind of materials used in their fabrication and in the pads.

Acknowledgements

The authors would like to express their appreciation to Miss Ch. Behrendt (Photolab.) and Mr. A. Kutzer and K. Helbig (Orthopaedic workshop) for their advice and help and Mrs. M. Bauer for typing the manuscript.

REFERENCES AND BIBLIOGRAPHY

AHLGREN, S. A., HANSEN, T. (1978). The use of lumbosacral corsets prescribed for low back pain. *Pros. Orth. Int.*, **2,** 101–104.

BAYERL, J., SCHUBJE, H. (1965). Die orthopädietechnische Versorgung. Volk und Gesundheit, Berlin, 256–268.

BLOHMKE, F. (1973). Die Orthesen für den Rumpf Technische Orthopädie. Thieme Stuttgart, 36–53.

CAILLIET, R. (1981). Low back pain syndrome 3 ed. F. A. Davis Company, Philadelphia, preface.

DAHMEN, G. (1981). Prinzipien der Orthesen. Versorgung. *Med. Ortho. Techn.*, **101,** 2–5.

DEANE, G., GREW, N. D. (1978). Some physical effects of lumbar spinal support orthoses. *J. Bone Jt. Surg.*, **60B,** 284–285, (abstract).

DOMMISSE, G. F. (1978). The lumbar disc brace. *S. Afr. Med. J.*, **53,** 1064–1066.

EICHLER, J. (1981). Spondyflex—ein neues Pelottensystem zur Behandlung lumbaler und lumbosacraler Syndrome. *Med. Orthop. Techn.*, **101,** 10–14.

EICHLER, J. (1979). Welche Orthese für chronische Schmerzzustände in Gebiet der Lenden-Kreuz-Region? *Orthopäde,* **8,** 356–365.

FORSELL, M. Z. (1981). The Back School, *Spine,* **6,** 104–106.

HELFET, A. J., LEE, D. M. G., (1978). Disorders of the lumbar spine. Lippincott, Philadelphia, 173–178.

HIRSCH, C., INGELMARK, B. E., MILLER, M. (1963). The anatomical basis for low back pain. Studies on the presence of sensory nerve endings in ligamentous, capsular and intervertebral disc structures in the human lumbar spine. *Acta. Orthop. Scand.*, **33,** 1–17.

HOHMANN, G. (1965). *Orthop. Techn.*, Enke Verlag Stuttgart, 79–80.

JOHN, H. (1981). Wirkungsweise und Anwendung der Rückenstützbandage mit Federpelotte und dynamischer Pelotte. *Med. Orthop. Techn.*, **101,** 7–9.

JORDAN, H. H. (1963). Orthopaedic appliances, the principles and practice of brace construction. 2 ed. C. Thomas, Springfield, Illinois, USA, 68–76.

KAPANDJI, I. A. (1974). The physiology of the joints. Vol. 3; the trunk and the vertebral column. Churchill Livingstone, Edinburgh, p. 78.

KIRKALDY-WILLIS, W. H., READ, S. E. (1968). An elastic support for the lumbar and lumbosacral spine. *Clin. Orthop.*, **59,** 131–135.

KRÄMER, J. (1981). Mieder und Korsettversorgung unter Berücksichtigung der lumbalen Entlastungshaltung. *Med. Orthop. Techn.*, **101,** 22–24.

KULAK, R. F., SCHULTZ, A. B., BELYTSCHKO, T. et al (1975). Biomechanical characteristics of vertebral motion segments and intevertoid discs. *Orthop. Clin. North. Am.*, **6,** 121–133.

LATURNUS, H. (1981). Erfahrungen met der Wirberlsäulenstreckbandage. *Med. Orthop. Techn.*, **101,** 15–18.

LINDEMANN, K., KUHLENDAHL, H. (1953). Die Erkrankungen der Wirbelsäule, Enke Stuttgart, 263.

MAIER, K. (1962). Röntgenologische Funktionsstudien an der Lendenwirbelsäule bei Fixierung durch gebräuchliche Korsette. *Z. Orthop.*, **95,** 319–330.

MORRIS, J. M., LUCAS, D. B., BRESLER, B. (1961). Role of the trunk in stability of the spine. *J. Bone. Jt. Surgery,* **43A,** 327–351.

MORRIS, J. M. (1974). Low back bracing. *Clin. Orthop.*, **102,** 126–132.

NACHEMSON, A., MORRIS, J. M. (1974). In vivo measurements of intradiscal pressure. Discometry, a method for the determination of pressure in the lower lumbar discs. *J. Bone. Jt., Surg.*, **46A,** 1077–1092.

NACHEMSON, A., LINDH, M. (1969). Measurement of abdominal and back muscle strength with and without low back pain. *Scand. J. Rehab. Med.*, **1,** 60–65.

NORTON, P. L., BROWN, T. (1957). The immobilizing efficiency of back braces. Their effect on the posture and motion of the lumbosacral spine. *J. Bone. Jt. Surg.*, **39A,** 111–139.

PERRY, J. (1970). The use of external support in the treatment of low back pain. *J. Bone. Jt. Surg.*, **52A,** 1440–1442.

RADIN, E. L., SIMON, Sh. R., ROSE, R. M., PAUL, I. L. (1979). Practical biomechanics for the orthopedic surgeon. Wiley, New York, 17.

SCHEDE, F. (1966). Die konservative Behandlung der Skoliose Ein Arbeitsbericht. *Z. Orthop.*, **102,** 1–15.

SCHMITT, E., HEIPERTZ, W. (1981). Rumpforthesen in der Therapie des Lumbalsyndroms. *Med. Orthop. Techn.*, **101,** 18–21.

SCHROEDER, S., RÖSSLER, H., HERMES, M. (1980). Miederversorgung der Lendenwirbelsäule unter Berücksichtigung biomechanischer Gesichtspunkte. *Orthop. Techn.*, **31 (9),** 121–126.

STEWART, J. (1975). Traction and orthopaedic appliances. Churchill Livingstone Edinburgh, 75–97.

WATERS, R. L., MORRIS, J. M., (1977). Effect of spinal supports on the electrical activity of muscles of the trunk. *J. Bone. Jt. Surg.*, **52A,** 51–60.

WHITE, A. A., PANJABI, M. M. (1978). Clinical biomechanics of the spine. Lippincott, Philadelphia, 371.

WILLIAMS, P. C. (1965). The lumbosacral spine, Blakiston Division McGraw-Hill, New York, 82.