Manual Medicine

Diagnostics

Jiří Dvořák and Václav Dvořák

With the Collaboration of Tomáš Drobný

Translated and edited by
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175 Mostly Colored Figures, 6 Tables

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Important Note: Medicine is an ever-changing science. Research and clinical experience are continually broadening our knowledge, in particular our knowledge of proper treatment and drug therapy. Insofar as this book mentions any dosage or application, readers may rest assured that the authors, editors and publishers have made every effort to ensure that such references are strictly in accordance with the state of knowledge at the time of production of the book. Nevertheless, every user is requested to carefully examine the manufacturer's leaflets accompanying each drug to check on his own responsibility whether the dosage schedules recommended therein or the contraindications stated by the manufacturers differ from the statements made in the present book. Such examination is particularly important with drugs which are either rarely used or have been newly released on the market.

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Foreword

The undersigned has neither received a formal education in manual therapy, nor does he practice such (this sentence is not a pleonasm!). Furthermore, he is neither disappointed by his own field or frustrated because of other reasons. When he recommended that this book should appear at all, this was not due to personal or complex-psychological motives, nor an innate trust in this form of medicine itself.

The reasons are, on the contrary, quite rational. As a recent poll by the Swiss Medical Society for Manual Medicine indicated, approximately 300,000 manipulations are performed by physicians in Switzerland every year. About 100 chiropractors manipulate nearly 800,000 times per year. This amounts to a total of some 1.1 million manipulations in Switzerland every year. We neurologists especially, however, tend to see the undesirable side effects and complications of manual medicine. Is this therefore not enough reason in itself to recommend a thorough explanation of one of the techniques and its fundamentals? Further, the author of this foreword has been privileged to have had numerous personal contacts with non-medical chiropractors and physicians practicing manual medicine who have demonstrated responsible and ethically irreproachable attitude, in depth training and convincing therapeutic success. This alone would be a good reason for a representative of formal, organized medicine to support a publication which advocates manual therapy.

On the other hand, one experiences in diverse discussions, as always in this field, that one school of thought is set against another, when irrational and unverifiable elements with confusing terminology come into play; actually, therapeutic acts begin to assume the form of pure magic! The beneficial effects of this therapy became simply a "last resort", albeit obligatory, alternative for treatment due to the ubiquitous prejudicial consensus of opinion concerning this form of medicine. Patient demands, however, or official control forced many therapists into a sterile confinement and restricted them in every case which presented itself into using this single approach in a one-sided intractability. A further reason in this respect for publishing one of these methods of treatment was the need for a clear and unambiguous statement of principles, claims and limitations.

This leads to the fourth and probably the most important reason for this publication: even though manual therapy has developed empirically, as indeed today's medicine has originally developed, it might nevertheless fulfill some of the patients' expectations by a direct, "close-hand" approach which corresponds to their wishes for a "magical" panacea. With its own intrinsic procedures, manual therapy can further be viewed as a challenge to the technical and impersonal aspects of modern medicine. All this, however, is not a reason to not subject manual medicine to scientific methodology. In this context, the term "scientific" implies:

- building on existing foundations, identifying the tangible phenomena, and
- making these comprehensible and learnable.

Many representatives of this type of treatment and other "alternatives" to formal medicine have largely evaded any meaningful discussion of their particular field of activity, when brought to task. Usually, they shelter behind a mass of esoteric terminology and avoid a rational promulgation of their fundamentals, preventing them from being studied.

The physicians Jiří Dvořák, who has a comprehensive knowledge of general medicine as well as a training in neurology, Václav Dvořák, trained in internal medicine, and Tomáš Drobný, with a surgical and orthopedic specialist training behind him, have all worked as students under the auspices of the internal specialist Max Sutter as well as pursuing their own interest in manual medicine. They were thus presented with the opportunity not only to demonstrate their reproducible successes in therapeutics, but also had the courage to establish the scientific basis of the principles pertaining thereto, and lay these open to discussion. They have done this knowing that the last word in this matter has not yet been reached. They would like their interpretation of the mechanisms of manual medicine to be scrutinized, challenged and perhaps corrected. To this end it is essential that the subject be candidly laid bare. Only in this respect is the chance presented for the material to become useful and valid in the long term. To this effect, this book is scientific.

Bern MARK MUMENTHALER

Foreword

Articular neurology is the branch of neurology that is concerned with the morphology, physiology, pathology, and clinical features of the innervation of the joints of the body (including those in the vertebral column), but until about 15 years ago this discipline did not exist as an organized body of knowledge, since it had never been studied systematically in the laboratory or the clinic. Happily, articular neurology has now been developed to the point where it forms one of the basic sciences of orthopedic medicine and surgery, as well as of clinical neurology.

The observations reported in this monograph represent an important clinical application of some of what is now known of articular reflexology in a diagnostic context, and as such should prove to be of considerable significance to practitioners of manual medicine and physical therapy, as well as of orthopedics, rheumatology, and neurology. For too long, manual medicine has existed as an empirical art rather than as a clinical science, but this monograph – based as it is on some of the scientific data currently available in the field of articular neurology – should go some way toward remedying this state of affairs. It therefore gives me considerable pleasure to contribute this foreword to a work that I hope will serve as a stimulus to clinicians in a variety of disciplines, as well as to practitioners of manual medicine.

London Prof. Dr. B. D. Wyke, M.D., B.S.
Director of the Neurological Unit,
Royal College of Surgeons of England

Preface

The ever-increasing interest in manual medicine has encouraged us to present this review of the methods and techniques currently used in this field, be they of general or specific diagnostic value. This book was written with both the general practitioner and the physician specializing in manual medicine in mind. In addition to presenting the biomechanics and the functional examination of the vertebral column, we have tried to correlate alterations in the soft tissues that cause pain (nonradicular spondylogenic syndromes) – which are so far only known emperically – with findings in basic research of the neurophysiological processes. In this sense, it seems only natural to begin by correlating the practical experiences gained through patient examination with the results of neurophysiological research concerning the phenomenon of pain. This correlation of clinical observations with experimental findings will perhaps stimulate further research of pain syndromes the causes of which are often unknown and that may pose a central problem to the physician using manual techniques.

We have deliberately excluded the radiology of the vertebral column and the orthopedic, rheumatological, and neurophysiological examinations, since they appear in the classic literature. It goes without saying that a differential diagnosis in manual medicine should be made in accordance with the standards of modern-day practice of the medical profession.

The physician is often confronted with patients who present with pain of unknown origin, which is known as "noninflammatory soft tissue rheumatism." Chapters 7 and 10 attempt to catalogue these painful syndromes and correlate them with the skeleton. They are based on observations made by Dr. M. Sutter, who has examined a large number of patients. His main contribution was to understand that painful syndromes arising from the spine and the extremities could be identified and correlated with the anatomy. This in turn determines the therapeutic approach – manual therapy being one of the choices. We are deeply indebted to Dr. Sutter for his extensive palpatory studies done over many years, as well as for his knowledge in this field. We had the opportunity of working closely with him between 1976 and 1979. Dr. Sutter's teaching presented us with the opportunity of working in the area of the "spondylogenic reflex syndromes" and subsequently to develop this review.

We also want to thank Prof. K. Ludwig and his coworkers Dr. Bauer and Dr. Schwitzgebel from the Anatomy Institute of the University in Basle for helpful suggestions and corrections. We would also thank Prof. M. Mumenthaler of the Neurological Department of the University Hospital in Berne for his help in preparing this book. We thank Prof. B. D. Wyke and his coworkers from the Neurological Unit of the Royal College of Surgeons of England, whose neurophysiological findings became the basis for the understanding of the spondylogenic reflex syndrome. Dr. Wyke's critical, yet encouraging, instructions inspired us to continue research in this field. With the kind permission of Prof. A. White, Harvard Medical School, and Prof. M. Panjabi, Yale University, we were able to use a number of illustrations depicted in their book, Clinical Biomechanics of the Spine, to clarify concepts in our chapters on the biomechanics of the vertebral column.

We would further like to mention our appreciation to Prof. P. E. Greenman, Michigan State University, College of Osteopathic Medicine, for his cooperation, invaluable suggestions, and his help in getting this book published and translated into English language.

Translating a work such as this is no easy task, especially when the terminology is subject to variation in both languages. Wolfgang Gilliar with his diligence and great interest in the subject matter has mastered this task. We thank him for the precision of his translation of the text.

Last, yet not least, we would like to thank Georg Thieme Verlag and Thieme-Stratton Inc. Special thanks are extended to Dr. D. Bremkamp and Mr. A. Menge for their cooperation as well as to everyone, even though not mentioned individually, who made this project feasible.

Berne and Bonaduz, September 1984

Jiří Dvořák
Václav Dvořák

Contents

1. Biomechanics and Functional Examination of the Vertebral Column

An understanding of the biomechanics of the spinal column is indispensable, not only for examination procedures, but also for the evaluation of roentgenograms and therapy. In this chapter therefore we place emphasis on the biomechanics based on the fundamental work by WHITE and PANJABI, 1978a and b. Described are only those methods of examination that, in addition to rheumatological, orthopedic, and neurological procedures, have proved to be useful.

1.1. Occipital-Atlanto-Axial Complex

1.1.1. Atlanto-Occipital Joint

The articulation between the skull and the atlas is formed by two paired structures, each pair consisting of the occipital condyle and the superior facets of the atlas. The articulating surfaces are oval, sometimes showing a beanlike configuration. The upper surface of the condyles is convex, and the surface of the superior facets of the atlas is concave. The sagittal axial angle of the joints is 50° to 60° for the adult (INGELMARK, 1947; BERNHARD, 1976) (Fig. **1**).

The frontal axial angle of the joints (Fig. **2**) results from lines drawn parallel to the articulating surfaces of the condyles. On the average, it is 124.2°

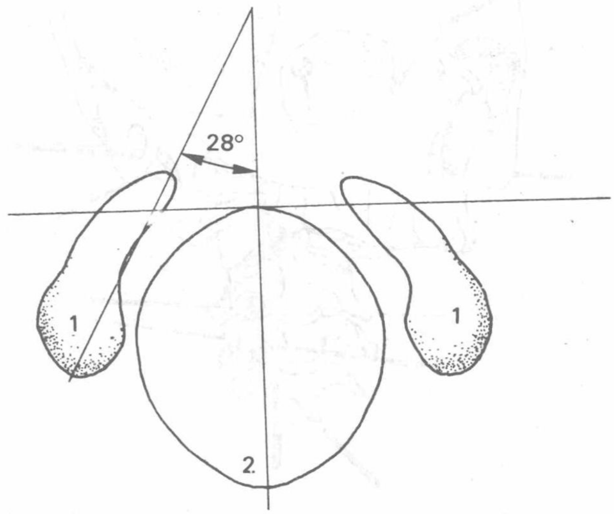


Fig. **1**. Sagittal angle of the joint axes for the occipital condyles (after *Ingelmark*, 1947). 1: occipital condyles; 2: foramen magnum.

(STOFF, 1976). This axial angle increases in the event of condylar hypoplasia and basilar impression.

VON LANZ and WACHSMUTH (1979) describe the joint between the skull and the atlas as a modified spherical articulation, with mobility about two axes according to the anatomical arrangement. The left and right joints acting in conjunction allow move-

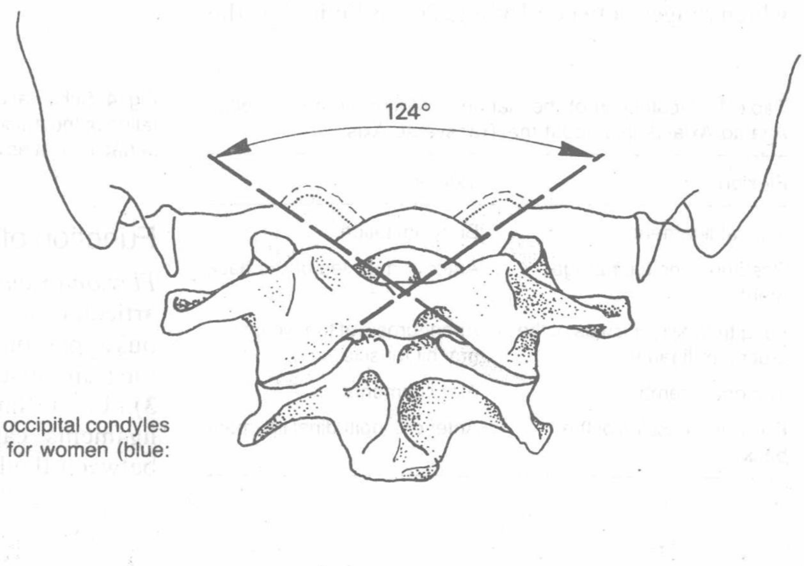


Fig. **2**. Frontal angle of the joint axes for the occipital condyles (after to *Stoff,* 1976) is 124° for men, 127° for women (blue: articulating surfaces).

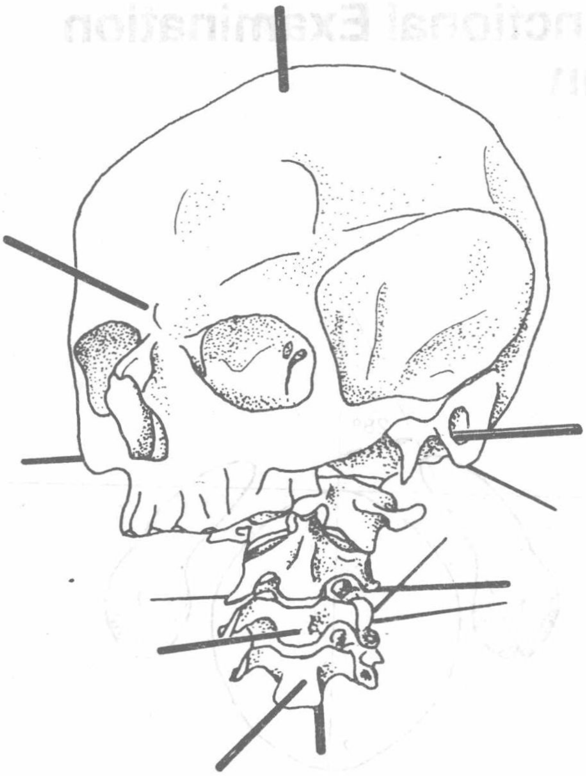


Fig. 3. Axes of motion of the occipital-atlanto-axial and cervical joints (after *Knese*, 1947/50).

ment about the larger transverse axis and the smaller sagittal axis.

Flexion and extension movements take place about the transverse axis, whereas lateral bending is about the sagittal axis (**Fig. 3**).

Function of the Atlanto-Occipital Joint

Flexion and extension (about the transverse axis), which ranges between 16° and 20°, is limited by the bony structures and the surrounding functional soft tissue (Table **1**).

Table **1** Restriction of the Range of Motion of the Occipital-Atlanto-Axial Joints about the Transverse Axis

Flexion	Extension
Nuchal ligament	Bony limitation
Posterior longitudinal ligament	Anterior muscles of the back
Longitudinal fasciculus of the cruciform ligament	Aponeurosis of the biceps brachii muscle
Tectorial membrane	Alar ligaments
Posterior muscles of the back	Anterior longitudinal ligament

Lateralbending about the sagittal axis measures 4° to either side. When the head is in a slightly flexed position, lateral bending reaches a maximum; when extended, such bending is prohibited by the alar ligaments.

Different data exist in the literature in regard to the rotation of the atlanto-occipital joint: FIELDING (1957, 1978), WHITE and PANJABI (1978a and b), and PENNING (1968) found no rotation, whereas DEPREUX and MESTDAGH (1974) contend that a rotation of 5° exists, which can increase substantially after atlanto-axial fusion. CAVIEZEL (1976) clinically examines the "passive terminal rotation" of the atlas in the test of resiliency.

1.1.2. Atlantoaxial Joint

The atlantoaxial joint is very important for manual medicine. Motion takes place in four articular spaces, one of which is designated the bursa atlantodentalis; this is the space between the transverse ligament of the atlas and the dens of the axis.

The middle atlantoaxial joint is located between the dens of the axis and the posterior surface of the anterior arch of the atlas. The two articular spaces of the lateral atlantoaxial joint are of primary importance. The joint surfaces are usually round, sometimes triangular and covered with cartilage of 1.4 to 3.2 mm thickness. The articular surfaces of the axis are convex, and those of the atlas are relatively flat, causing an anterior and posterior gap of 2 to 5 mm (KNESE, 1947/50) (Fig. **4**). The joint capsule is wide and flabby, and from the medial wall a cuneiform synovial fold reaches into the articular space (meniscoid).

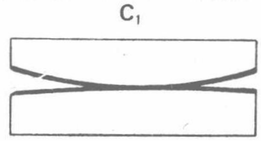


Fig. **4**. Schematic representation of the articulating surfaces of atlas and axis.

Function of the Atlantoaxial Joints

Flexion/extension: The bony structures of the articular surfaces along with the securing ligamentous apparatus allow only minimal movement about the transverse axis of not more than 10 to 15°, (Fig. **3**). In the lateral x-ray, the effectiveness of the ligaments can be determined by the distance between the back of the anterior arch of the atlas nd the dens of the axis. As this distance increases, so does insufficiency.

Lateral flexion: Lateral bending between C_1 and C_2 is only possible with simultaneous rotation about the axis.

This is described as forced rotation and is mainly the result of the physiological function of the alar ligaments. LEWIT (1970) and JIROUT (1973) report dislocation of the atlas in the direction of the bending when lateralbending is forced.

Rotation: The head and atlas rotate simultaneously on the axis about the dens. The rotational axis passing through the dens of the axis is determined by the transverse ligament of the atlas (Fig. **3**). The range of motion to each side is normally 40° to 50°, which is about half of the total cervical spine rotation. Kinematographic studies by FIELDING (1957, 1978) clearly demonstrate that starting from the neutral position rotation takes place in the atlantoaxial joints first. Once their motion is completed, the lower cervical spine segments begin to rotate. The limitation of the rotation is primarily effected by the alar ligaments (Figs. **6, 7**).

1.1.3. Ligaments of the Occipital-Atlanto-Axial Complex

In this context, only those ligaments are described that appear important for the function of the atlanto-occipital and atlanto-axial joints, such as the alar ligaments and the cruciform ligament of the atlas.

Alar Ligaments

LUDWIG (1952) describes the alar ligament as an irregular, quadrilateral pyramid-like trunk. The rectangular base lies against the superior two-thirds of the lateral surface of the dens. The superior, posterior and anterior surfaces connect the dens with the occipital condyle, and the inferior and lateral surfaces connect the dens with the lateral mass of the atlas (Fig. **5**).

Function of the Alar Ligaments

During extension of the head, the alar ligament is stretched, whereas during flexion it is relaxed.

During rotation of the atlantoaxial joint, the ligament of the opposite side is stretched and "rolled up" around the dens of the axis; the ligament on the same side relaxes. Thus, during rotation to the right, the left alar ligament is "rolled up", and the right ligament relaxes (Fig. **6**).

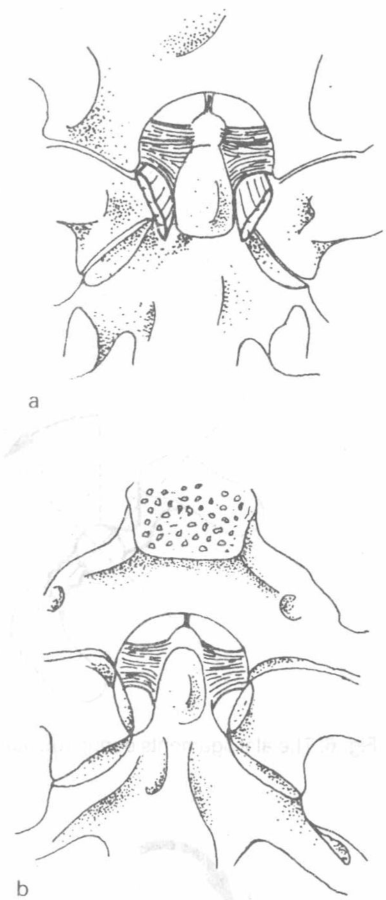


Fig. **5**. Alar ligaments: **(a)** posterior view, **(b)** anterior view (after *Ludwig*, 1952).

During bending to one side, the alar ligament of that same side relaxes, and the stretched ligament of the opposite side causes a forced rotation of the axis in the direction of the bending due to the attachment to the dens of the axis (the spinous process of the axis moves contralaterally; Fig. **7**). Thus, the strong alar ligaments are able to limit the rotation of the atlantoaxial joints.

Cruciform Ligament of the Atlas

The cruciform ligament consists of the horizontal transverse ligament of the atlas and the vertical longitudinal fasciculi. The transverse ligament of the atlas arises from the medial surfaces of the lateral masses of the atlas, portions of the fibers being attached to the tip of the dens. The ligament consists primarily of collagen fibers that can be irreversibly stretched under strong tension (KENNEDY et al., 1976). The central portion of the ligament is 10 mm high, 2 mm thick, and covered by a thin layer of cartilage. The longitudinal fasciculi

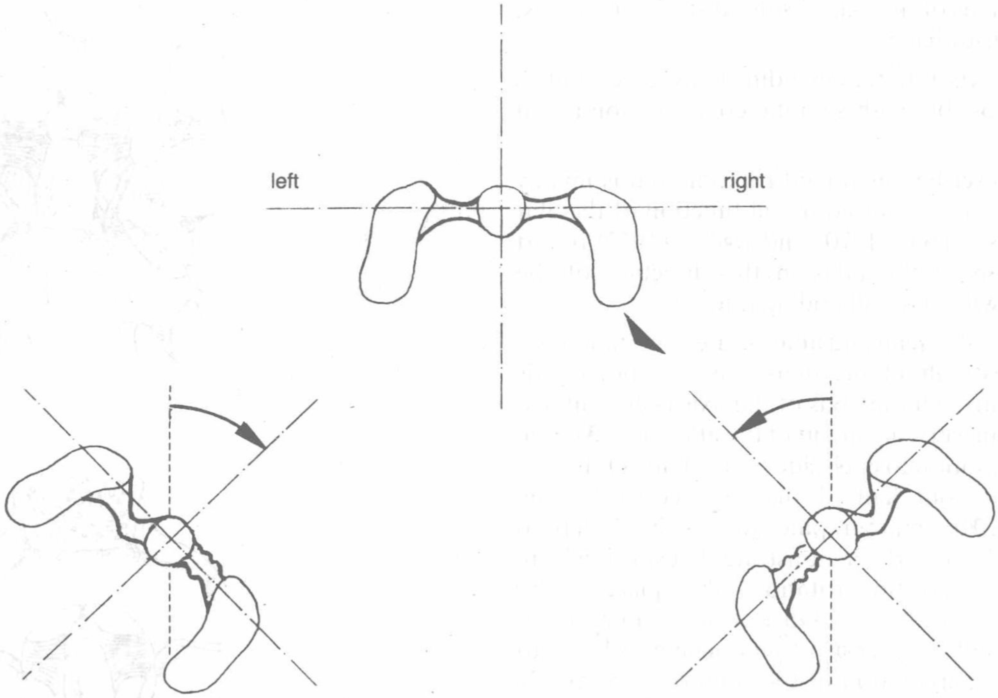


Fig. 6. The alar ligaments during rotation of the atlantoaxial joint.

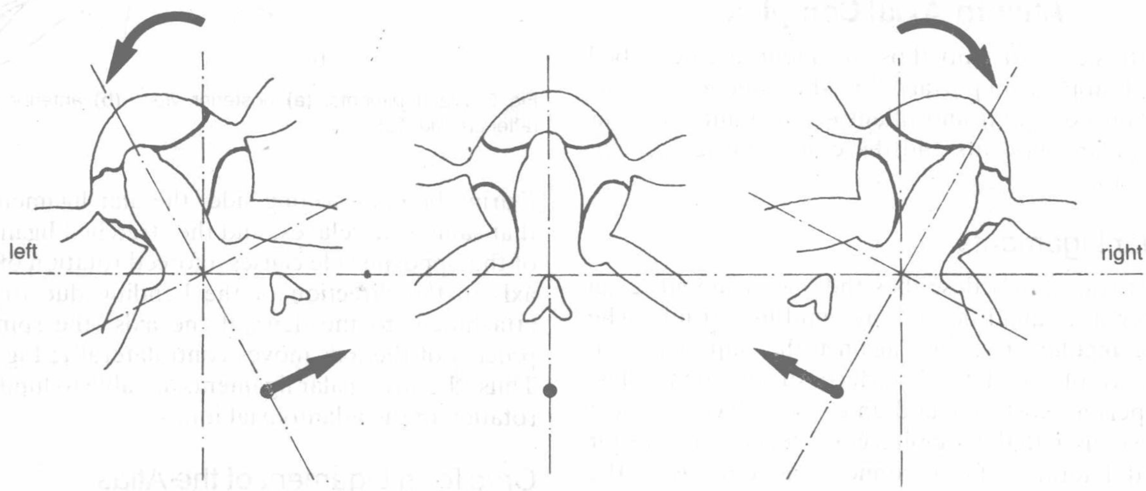


Fig. 7. Illustration of forced rotation of the axis with lateral bending of the head.

are weak and are present inconsistently. They lead into the atlanto-occipital membrane (Fig. 8).

Function of the Cruciform Ligament of the Atlas

The functions are to guarantee the physiological rotation of C_1–C_2 and to protect the spinal cord from the dens of the axis.

Lesions of the Alar Ligaments and the Cruciform Ligament of the Atlas

Macalister (1893) found that the transverse ligament of the atlas tears at a load of 130 kg. Fielding et al. (1974) examined the tensile strength of the alar ligaments and the cruciform ligament of the atlas in 20 corpses. They found that the ligaments tear at a load of 40 to 180 kg (average, 110 kg).

The transverse ligament of the atlas tears when stretched beyond 4.8 to 7.6 mm. Overstretching will lead to tearing of the collagenous fibers, which can be seen on x-rays as an increase in the distance between the dens and the posterior surface of the anterior arch of the axis of more than 3 mm (more prominent in x-rays taken in the flexed position). With a distance of 7 mm, complete separation of the transverse ligament from the atlas is to be expected; with distances greater than 10 to 12 mm, tearing of the alar ligaments is to be expected.

The spatial relationship between the bony structures of the atlas, the dens of the axis, the spinal cord, and the free zone is designated as an anatomical constant. Generally, the rule of thirds by STEELE (1968) has proved valuable (Fig. **9**). One-third of the space is occupied by the dens, one-third by the spinal cord, and one-third by a free space, the so-called safety zone of the spinal cord.

Considering the anatomical position of the cardiac and respiratory centers in the medulla oblongata, the double control is plausible in regard to the prevention of a dens dislocation via the alar ligaments and the transverse ligament of the axis. HUGUENIN (personal communication, 1980) points out the clinical symptomatology and the resulting changes seen on radiographs for the partial and complete tearing of the ligaments in the occipital-atlanto-axial joint region, both in functional and computer-directed tomograms.

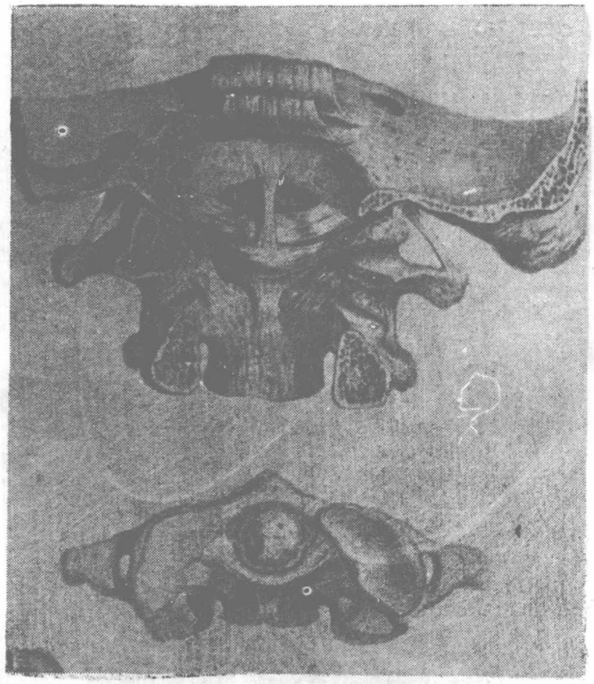


Fig. **8**. Representation of the cruciform ligament and other ligaments of the occipital-atlanto-axial complex. Above: posterior view; below: superior view (from *Arnold*, 1845).

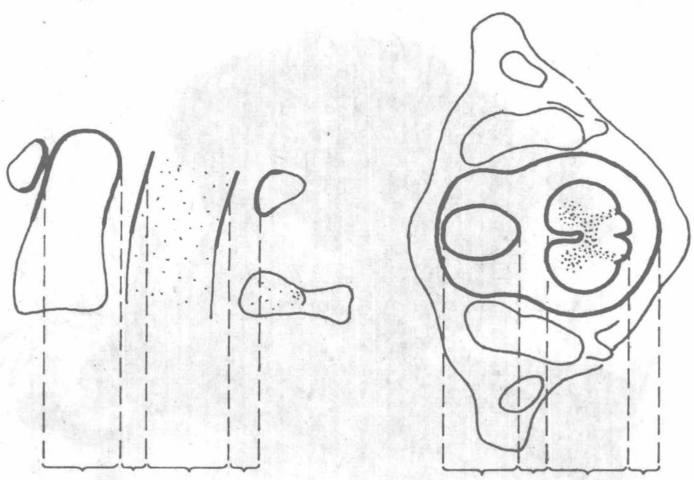
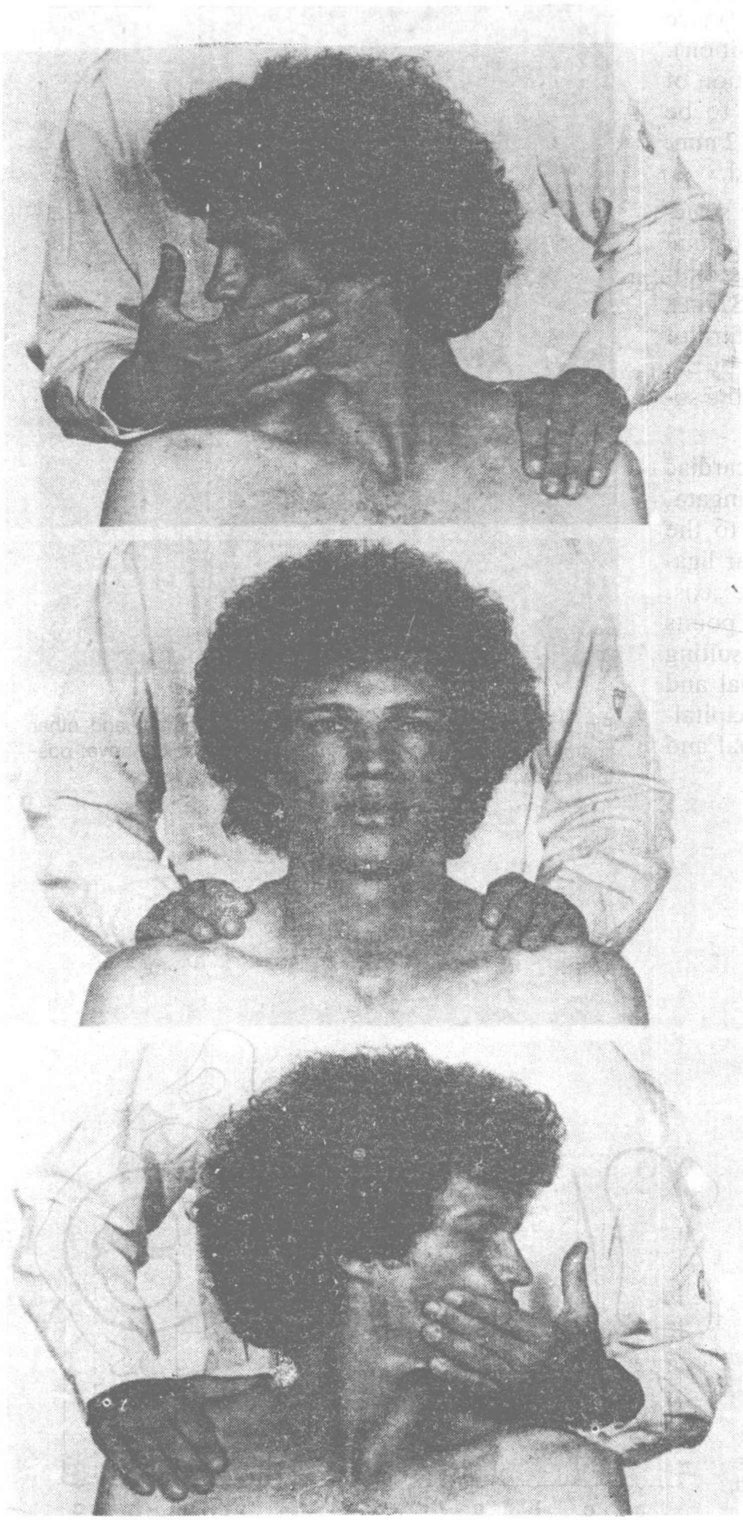


Fig. **9**. Steel's rule of thirds (1968) (schematic): a = b = 2c = ⅓ (a + b + 2c). a: dens axis; b: spinal cord, c: safety zone.

1.1.4. Functional Examination of the Occipital-Atlanto-Axial Joints

Rotation from the neutral position: This movement takes place in the entire region of the cervical spine and the first four thoracic vertebrae and measures 90° to either side (Fig. **10**).

Rotation from flexion: With maximal flexion, the lower segments of the cervical spine are locked,



a

b

c

Fig. **10**. Rotation of the head starting from the neutral position (a: 90° to the right; b: 0°; c: 90° to the left).

that is, the individual joints are brought into their final (end) position.

Further rotation continuing from this position is then only possible in the atlantoaxial joint. Normally, it measures 45° to either side (Fig. **11**). A decrease in the rotation indicates a hypomobile dysfunction in the C_1–C_2 vertebral unit.

A value greater than 45° is usually the result of an

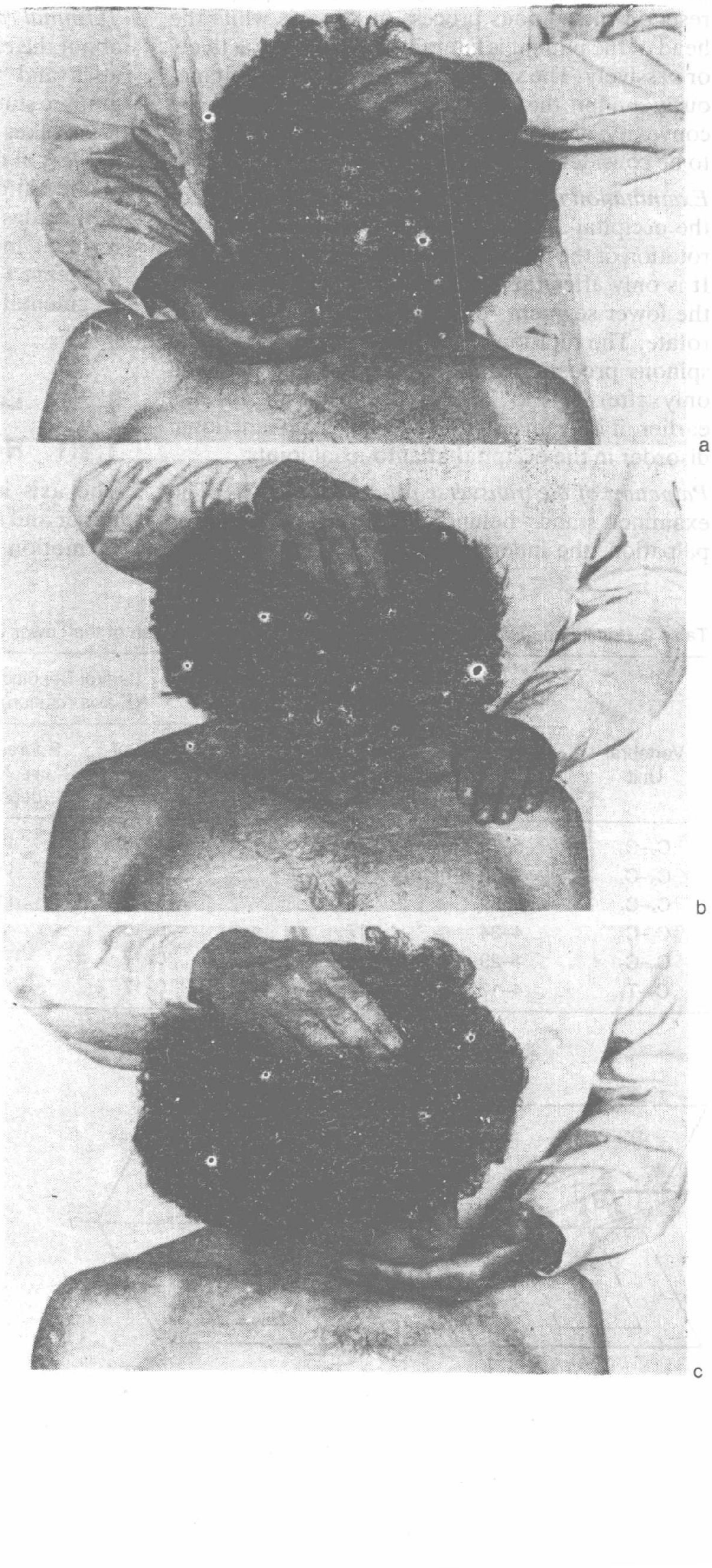


Fig. **11**. Rotation of the head starting from the flexed position (a: 45° to the right; b: 0°; c: 45 to the left).

improperly conducted examination. Seldom is it an indication of insufficient brake function of the alar ligaments (caution: hypermobility may result in a "rubberman").

Forced rotation of the axis with lateral flexion (lateralbending): The finger used for palpation rests on the spinous process of the axis while the head of the patient is laterally flexed either actively or passively. The spinous process moves simultaneously under the finger in the direction of the convexity; absence of a forced rotation therefore is to be considered pathological.

Examination of axis rotation: The biomechanics of the occipital-atlanto-axial complex shows that the rotation of the head begins in the atlantoaxial joint. It is only after the completion of this motion that the lower segments of the cervical spine begin to rotate. The rotation of the axis is palpated over the spinous process of the axis, but can be detected only after 25° to 30°. If this rotation appears earlier, it is again a sign of a hypomobile functional disorder in the occipital-atlanto-axial joints.

Palpation of the transverse process of the axis: The examiner stands behind the sitting patient. For palpation, the index finger is placed on the tip of the mastoid process and the ring finger is placed on the edge of the ramus of the mandible. The free middle finger presses deeply between these two bony projections and locates the deep transverse process of the atlas, which is normally painful upon pressure.

Terminal rotation of the atlas: Disagreement exists about the elastic rotational movement between the atlas and the occiput. According to kinematographic studies, no rotation in the atlanto-occipital joint takes place. However, when the transverse process of the axis is palpated exactly and the head rotated into its maximal position, an elastic motion of the atlas can be felt. The absense of this elastic, resilient motion, according to Lewit (1970) and Caviezel (1976), is an indication of the "blocking" (segmental dysfunction) of the atlanto-occipital-joints.

1.2. Lower Cervical Spine

1.2.1. Biomechanics

The axis is a transitional vertebra between the upper and lower cervical spine. The greatest range of motion takes place in the mid-cervical spine

Table 2 Limits and Representative Values of Range of Rotation of the Lower Cervical Spine (after *White* and *Panjabi* 1978a)

	Flexion/Extension (X axis rotation)		Lateral Bending (Z axis rotation)		Axial Rotation (Y axis rotation)	
Vertebral Unit	Limits of Ranges (degrees)	Representative Angle (degrees)	Limits of Ranges (degrees)	Representative Angle (degrees)	Limits of Ranges (degrees)	Representative Angle (degrees)
C_2–C_3	5–23	8	11–20	10	6–28	9
C_3–C_4	7–38	13	9–15	11	10–28	11
C_4–C_5	8–39	12	0–16	11	10–26	12
C_5–C_6	4–34	17	0–16	8	8–34	10
C_6–C_7	1–29	16	0–17	7	6–15	9
C_7–T_1	4–17	9	0–17	4	5–13	8

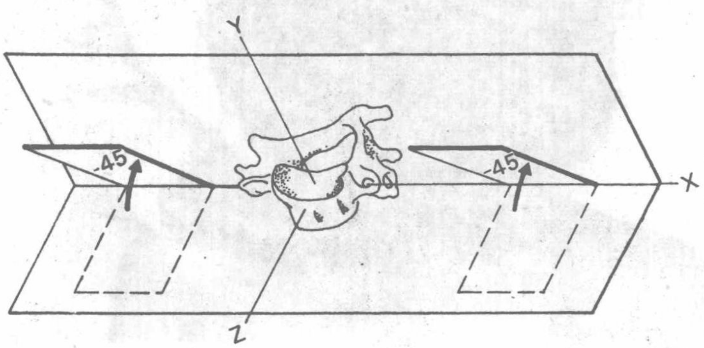


Fig. 12. Graphical representation of the facet joint inclinations and axes of motion for vertebra C_4 (after *White* and *Panjabi*, 1978a).

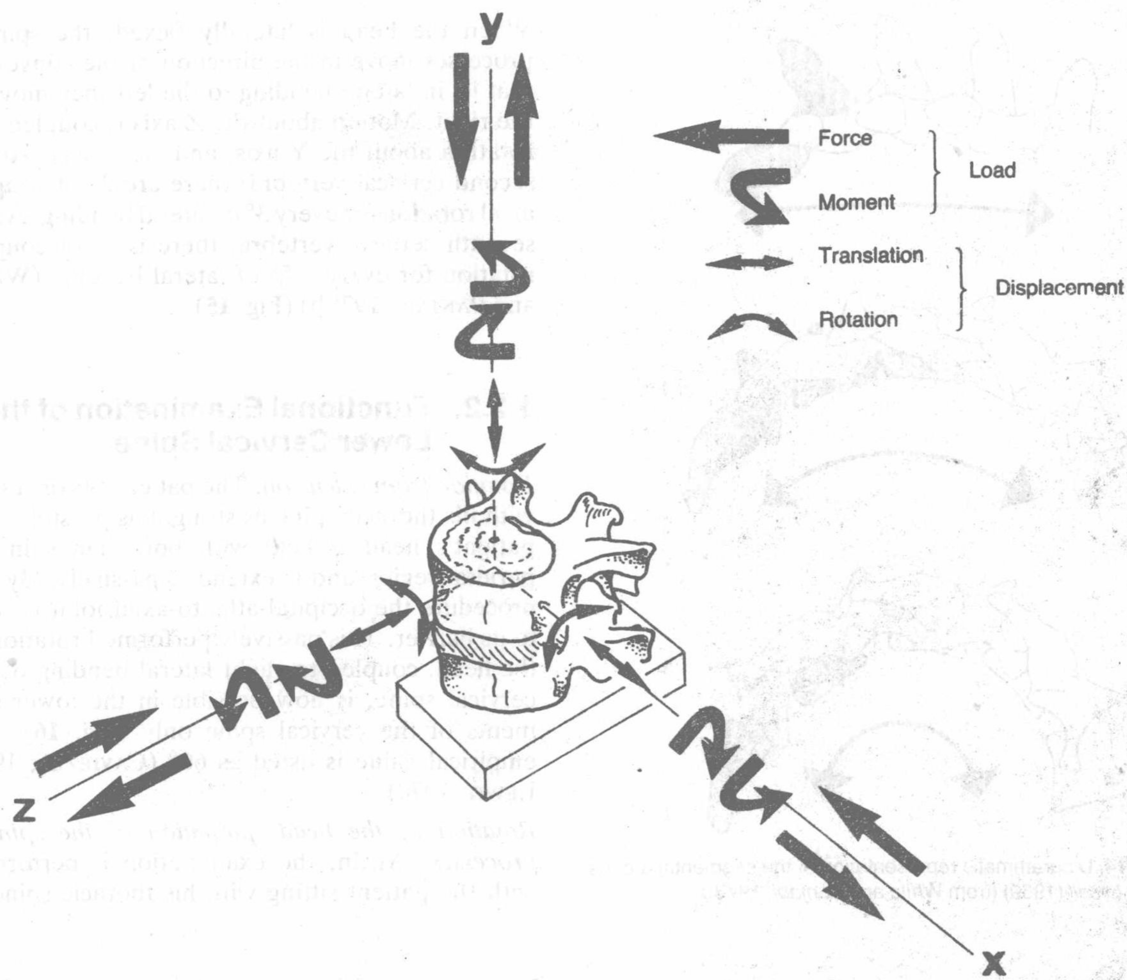


Fig. **13**. A three-dimensional coordinate system has been placed at the center of the upper vertebral body of a vertebral unit (motion segment). A total of 12 load components, linear and rotatory, can act on these axes; the application of any one of the load components (linear or rotatory) produces displacement of the upper vertebra with respect to the lower vertebra. The displacement consists of translation and rotation (after *White* and *Panjabi*, 1978 a).

region where the following motions are possible: flexion/extension, lateral bending (lateral flexion), and rotation (Table **2**).

The inclination of the central and lower cervical spine facets is 45° to the horizontal plane. The lower segments are steeper than the upper segments (Fig. **12**).

The motions possible in an individual segment (vertebral unit) can be considered as the combined translatory-rotatory motion about the respective axis of the three-dimensional coordinate system (LYSELL, 1969). Rotation about the X axis is identical with flexion and extension, about the Y axis with rotation, and about the Z axis with lateral-bending (Fig. **13**).

For flexion and extension, LYSELL (1969) describes a so-called top angle up on which the individual segments move. This so-called segmental arch is flat at C_1, and almost semicircular at C_7 (Fig. **14**). The top angle is determined by the inclination of the individual facets and the condition of the intervertebral disk.

Coupling Patterns With Lateral Flexion (Lateral Bending) and Rotation

LYSELL (1969) postulated and measured the coupling patterns for lateral flexion and rotation of the cervical spine. These coupling patterns are of clinical importance and are evaluated during the functional examination.