

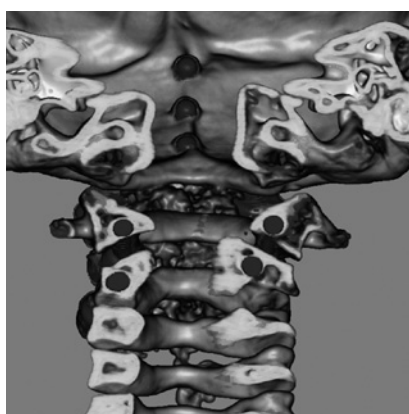
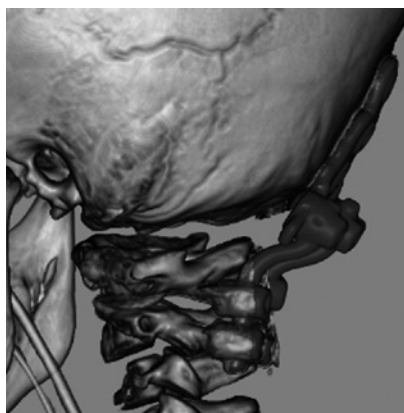


Specials thanks to the following

Foundation Fund Renaissance

Jan Štulík et al.

CERVICAL SPINE TRAUMA



**Friedrich Magerl
Petr Šebesta
Jan Kryl
Tomáš Vyskočil
Zdeněk Klézl**



Principal author

prof. Jan Štulík, M.D., Ph.D.

Center for Spinal Surgery University Hospital Motol, Prague, Czech Republic

Reviewers

ass. prof. Jiří Stehlík, M.D., Ph.D.

Department of Orthopaedic Surgery, Hospital Budweis, Ltd., Czech Republic

Jiří Chrobok, M.D., Ph.D.

Department of Neurosurgery, Hospital Na Homolce, Prague, Czech Republic

Jan Štulík et al.

CERVICAL SPINE TRAUMA

First edition

Published by Galén Publishing House, Na Bělidle 34, 150 00 Praha 5

Editor-in-Chief PhDr. Lubomír Houdek

Responsible Editor Jana Šedová

Illustrations Karel Vávra

Documentation from the authors' archives

Typesetting Petra Veverková, Galén

Print Omikron Praha, Doudova 22, 147 00 Praha 4

Intended for specialist public

G311026

www.galen.cz

All rights reserved.

No part of this book may be reproduced in any form by any electronic or mechanical means (including photocopying or recording) without permission in writing by publisher. Authors, organizers and publisher have made every effort to ensure that information about medical products correspond to the latest knowledge available at the time of preparing the work. The publisher is not responsible for the use of these products and recommends to follow the manufacturers' product information and package inserts, including contraindications, dosages and precautions. This applies particularly to rarely used or manufacturer's marketed medical products.

The text contains trademarks of medical and other products. Absence of trademark symbols (®, TM etc.) shall not mean that the trademarks are not protected.

© Galén, 2012

ISBN 978-80-7262-881-0

Authors

Principal author

prof. Jan Štulík, M.D., Ph.D.
Center for Spinal Surgery University Hospital Motol, Prague, Czech Republic

Contributors:

prof. Friedrich Magerl, M.D.
St. Gallen, Switzerland

Petr Šebesta, M.D.
Center for Spinal Surgery University Hospital Motol, Prague, Czech Republic

Jan Kryl, M.D.
Center for Spinal Surgery University Hospital Motol, Prague, Czech Republic

Tomáš Vyskočil, M.D.
Center for Spinal Surgery University Hospital Motol, Prague, Czech Republic

ass. prof. Zdeněk Klézl, M.D., Ph.D.
Royal Derby Hospital, United Kingdom

Petr Nesnídal, M.D.
Center for Spinal Surgery University Hospital Motol, Prague, Czech Republic

Michal Barna, M.D.
Center for Spinal Surgery University Hospital Motol, Prague, Czech Republic

On multicenter studies and other articles in the literature cooperated:

prof. Petr Havránek, M.D., Ph.D., Jiří Chrobok, M.D., Ph.D., ass. prof. Martin Krbec, M.D., Ph.D.,
Richard Lukáš, M.D., Ph.D., prof. Pavel Pafko, M.D., Ph.D., Tomáš Pešl, M.D., Ph.D., ass. prof. Petr Suchomel, M.D.,
Ph.D., Jiří Šrámek, M.D., Stanislav Taller, M.D.

Contents

1. Introduction	1
2. History	3
2.1. Ancient history	3
2.2. The Middle Ages.....	4
2.3. Renaissance	4
2.4. Major discoveries	5
2.4.1. Acute injuries to the central spinal cord	6
2.4.2. Whiplash injury	6
2.5. Evolution of treatment	6
2.5.1. Laminectomy	7
2.6. Posterior cervical spine fixation	7
2.6.1. Interspinous wiring techniques	7
2.6.2. Facet wiring techniques	7
2.6.3. Interlaminar clamps	8
2.6.4. Lateral mass screws and plates	8
2.6.5. Lateral mass screws and rods	8
2.6.6. Transpedicular screws	8
2.7. Anterior cervical spine fixation	8
2.7.1. Anterior exposure of the cervical spine	9
2.7.2. Anterior cervical plates	9
2.8. Atlantoaxial fusion	9
2.9. Direct osteosynthesis of the dens	10
3. Evolution of the cervical spine	14
3.1. Prenatal development	15
3.1.1. Blastema stage.....	16
3.1.1.1. Presomite stage	16
3.1.1.2. Somite stage	16
3.1.2. Cartilaginous stage	17
3.1.3. Ossification stage	17
3.2. Postnatal development	17
3.3. Congenital anomalies and developmental defects	18
4. Anatomy of the cervical spine	19
4.1. Anatomy of the vertebra	19
4.1.1. Occipital bone (C0).....	19
4.1.2. Atlas (C1).....	21
4.1.3. Axis (C2).....	23
4.1.4. Vertebrae of the middle and lower cervical spine (C3–C7)	23
4.1.5. Vertebrae of the upper thoracic spine (T1–T3)	24
4.2. Cervical spine junctions	24
4.2.1. Craniovertebral articulation	24
4.2.2. Ligaments of the spine	27
4.2.3. Intervertebral disc	27
4.2.4. Intervertebral joints	27
4.3. Muscles and fasciae of the cervical spine	28
4.4. Blood supply to the spine and spinal cord	29
4.5. Vertebromedullary topography	32
4.6. Topographical anatomy of the cervical spine	32
5. Biomechanics of the cervical spine	35
5.1. Kinematics of the functional spinal unit	37
5.1.1. Occipitoatlantoaxial complex C0–C1–C2.....	37
5.1.2. Lower cervical spine C3–C7.....	37
5.1.3. Thoracic spine	38
5.2. Spinal cord and its physical properties.....	38
5.2.1. Physical properties of the spinal cord	38
5.2.2. Functional biomechanics of the spinal cord	39
5.3. Stability of the spine	39
5.3.1. Theory of the spinal stability	39
5.3.2. Theory of spinal columns	40
5.3.3. Instability of the spine	41
6. Diagnostics of cervical spine injuries	43
6.1. Clinical examination of patients with a cervical spine injury	43
6.1.1. History and clinical examination....	43
6.1.2. Neurological examination	43
6.1.2.1. Examination of motor lesion	43
6.1.2.2. Examination of reflexes....	44
6.1.2.3. Sensory examination	44

6.1.2.4. Vertical topographical anatomy of a spinal cord lesion	46	8.1.6. Smith-Robinson anterior approach.....	70
6.1.2.5. Horizontal topographical anatomy of a spinal cord lesion	46	8.1.7. Trans-sternal approach	73
6.1.2.6. Spinal cord injury clinical syndromes.....	47	8.1.8. High thoracotomy.....	73
6.1.2.7. Classification of spinal cord lesions	48	8.1.9. Transaxillary approach	77
6.1.2.8. Radicular syndromes.....	48	8.2. Lateral approaches	77
6.2. Neurophysiological examinations.....	49	8.2.1. Lateral approach (Verbiest).....	77
6.2.1. Electromyography	49	8.2.2. Lateral approach (Hodgson).....	77
6.2.2. Electroneurography	49	8.2.3. Supraclavicular approach.....	78
6.2.3. Somatosensory evoked potentials (SSEP).....	49	8.3. Posterior approaches.....	78
6.2.4. Motor evoked potentials (MEP)....	49	8.3.1. Median approach.....	78
6.3. Imaging methods	49	9. Implants used in the region of the cervical spine	81
6.3.1. Radiologic examination.....	50	9.1. Wires, cables	81
6.3.2. Conventional tomography	52	9.2. Screws	81
6.3.3. Computer tomography (CT)	52	9.3. Anterior cervical plates	82
6.3.4. Myelography	55	9.3.1. First generation plates	82
6.3.5. Magnetic resonance imaging (MRI).....	55	9.3.2. Second generation plates.....	83
6.3.6. Positron emission tomography (PET)	56	9.3.3. Third generation plates (dynamic plates).....	84
6.3.7. Scintigraphy	56	9.4. Cages	84
7. Classifications of cervical spine injuries.....	58	9.5. Posterior cervical plates and clamps.....	86
7.1. Classifications of injuries to the upper cervical spine and the craniocervical junction	58	9.6. Rod-screw fixation systems	86
7.2. Classifications of injuries to the lower cervical spine and the cervicothoracic junction	58	10. Injuries to the upper cervical spine	90
7.2.1. Cloward's classification.....	59	10.1. Occipital condyle fractures (C0).....	90
7.2.2. Allen's classification	60	10.1.1. Types of fractures and mechanism of injury.....	90
7.2.3. Aebi's and Nazarian's classification	60	10.1.2. Anatomical note	91
7.2.4. Magerl's AO classification	60	10.1.3. Clinical finding	91
7.2.5. Moore's classification.....	64	10.1.4. Diagnostics.....	92
7.2.6. Vaccaro's classification	64	10.1.5. Differential diagnosis	93
8. Surgical approaches to the cervical spine.....	66	10.1.6. Method of treatment	93
8.1. Anterior surgical approaches.....	66	10.1.7. Our own experience with treatment of the occipital condyle fractures	93
8.1.1. Transoral approach.....	66	10.2. Atlanto-occipital dislocation of C0-C1 (AOD).....	94
8.1.2. Transmandibular approach with a median glosotomy	66	10.2.1. Types of dislocations and mechanism of injury.....	94
8.1.3. Transmandibular transcervical approach.....	69	10.2.2. Clinical finding	96
8.1.4. Anterior retropharyngeal approach.....	69	10.2.3. Diagnostics.....	97
8.1.5. Anterolateral retropharyngeal approach.....	70	10.2.4. Graphic techniques of evaluation....	97
		10.2.5. Differential diagnosis	98
		10.2.6. Method of treatment	98
		10.2.7. Our experience in the treatment of atlanto-occipital dislocation ...	100
		10.3. Injury to the atlas (C1)	104
		10.3.1. Isolated fracture of the anterior arch of the atlas	107
		10.3.1.1. Mechanism of injury.....	107
		10.3.1.2. Clinical finding.....	108
		10.3.1.3. Diagnostics	108
		10.3.1.4. Differential diagnosis	108
		10.3.1.5. Method of treatment.....	108

10.3.2. Isolated fracture of the posterior arch of the atlas	108	10.4.5.1. Atlantoaxial fixation by transarticular screws according to Magerl.....	130
10.3.2.1. Mechanism of the injury.....	109	10.4.5.2. Atlantoaxial fixation using the polyaxial screw-rod system according to Harms	136
10.3.2.2. Clinical finding	109	10.5. Injury to epistropheus (C2)	141
10.3.2.3. Diagnostics	109	10.5.1. Fracture of the dens	141
10.3.2.4. Differential diagnosis	109	10.5.1.1. Types of fractures and mechanism of injury	141
10.3.2.5. Method of treatment.....	109	10.5.1.2. Clinical finding.....	143
10.3.3. Combined fracture of the anterior and posterior arches of the atlas (Jefferson fracture)	109	10.5.1.3. Diagnostics	143
10.3.3.1. Mechanism of injury.....	110	10.5.1.4. Differential diagnosis	143
10.3.3.2. Clinical finding.....	111	10.5.1.5. Method of treatment.....	144
10.3.3.3. Diagnostics	112	10.5.1.6. Multicenter study of direct screw osteosynthesis of the dens	147
10.3.3.4. Differential diagnosis	113	10.5.1.7. Fracture of the dens in elderly patients.....	151
10.3.3.5. Methods of treatment ...	113	10.5.2. Non-union of the dens	156
10.3.4. Isolated fracture of the lateral mass of the atlas	114	10.5.2.1. Risk of a non-union.....	157
10.3.5. Fracture of the transverse process of the atlas.....	115	10.5.2.2. Diagnostics	157
10.3.6. Our own series of patients with an injury to the atlas	115	10.5.2.3. Method of treatment.....	157
10.4. Atlantoaxial dislocation of C1–C2 (AAD).....	116	10.5.3. Os odontoideum	157
10.4.1. Anterior atlantoaxial dislocation	116	10.5.3.1. Etiology	157
10.4.1.1. Mechanism of the injury.....	116	10.5.3.2. Diagnostics	160
10.4.1.2. Clinical finding.....	117	10.5.3.3. Classification	161
10.4.1.3. Diagnostics	117	10.5.3.4. Method of treatment.....	161
10.4.1.4. Differential diagnosis	117	10.5.3.5. Case report of a patient with os odontoideum....	162
10.4.1.5. Method of treatment.....	118	10.5.4. Hangman's fracture (traumatic spondylolisthesis of C2–C3, FRA)	166
10.4.2. Atlantoaxial rotatory dislocation	119	10.5.4.1. Type of fractures and course of the fracture line	166
10.4.2.1. Types of injuries and mechanism of injury	120	10.5.4.2. Mechanism of injury.....	168
10.4.2.2. Clinical finding.....	121	10.5.4.3. Clinical finding.....	168
10.4.2.3. Diagnostics	121	10.5.4.4. Diagnostics	169
10.4.2.4. Method of treatment.....	121	10.5.4.5. Differential diagnosis	169
10.4.2.5. A case study of a patient with atlantoaxial rotatory dislocation.....	122	10.5.4.6. Method of treatment.....	169
10.4.3. Posterior atlantoaxial dislocation	124	10.5.5. Non-dens, non-hangman's fractures of C2.....	172
10.4.3.1. Mechanism of injury.....	124	10.5.5.1. Types of injuries.....	172
10.4.3.2. Diagnostics	124	10.5.5.2. Clinical finding.....	172
10.4.3.3. Clinical finding.....	124	10.5.5.3. Diagnostics	172
10.4.3.4. Method of treatment.....	124	10.5.5.4. Method of treatment.....	173
10.4.4. Vertical atlantoaxial distraction.....	125	10.6. Combined C1–C2 fractures.....	174
10.4.4.1. Mechanism of injury.....	125	10.6.1. Types and mechanism of injuries....	174
10.4.4.2. Diagnostics	125	10.6.2. Clinical finding	176
10.4.4.3. Clinical finding	126	10.6.3. Diagnostics.....	176
10.4.4.4. Method of treatment	126	10.6.4. Differential diagnosis	176
10.4.5. Atlantoaxial fusion	127	10.6.5. Method of treatment	176
		10.6.6. Our experience in the treatment of combined C1-C2 fractures.....	177

10.7. Occipitocervical fixation	181	13. Cervical spine injuries in children and adolescents	241
10.7.1. Our series of occipitocervical fixations: long-term follow-up of 57 patients	184	13.1. Anatomical and biomechanical specific features.....	241
11. Injuries to the middle and lower cervical spine	202	13.2. Types of injuries.....	242
11.1. Treatment of the lower cervical spine injuries.....	202	13.3. Neurological lesions as part of the injury	243
11.1.1. Conservative treatment	202	13.3.1. Spinal cord injury without radiographic abnormality	243
11.1.2. Surgical treatment	203	13.4. Lethal consequences of spinal injuries.....	243
11.1.2.1. General principles of surgical treatment	203	13.5. Posttraumatic deformities of the spine	244
11.1.2.2. Surgical treatment from anterior approach.....	204	13.6. Methods and treatment results.....	244
11.1.2.3. Surgical treatment from posterior approach.....	210	13.7. Our own group of pediatric patients with spinal injuries	244
11.1.3. Halo fixation, halo traction	217	14. Cervical spine injuries in patients older than 65 years	252
11.2. Injuries to the middle and lower cervical spine treated with a monocortical plate system.....	221	14.1. The authors' own group of patients over the age of 65 years with a cervical spine injury	255
11.3. Hyperextension injury.....	224	15. Kyphotic deformities of the cervical spine	262
11.3.1. Our group of patients with hyperextension injury to the cervical spine	226	15.1. Etiology, mechanism of the development and clinical finding.....	262
12. Injuries to C7–T3 cervicothoracic junction	233	15.2. Diagnostics.....	262
12.1. Our own group of patients with internal fixation of the cervicothoracic junction	237	15.3. Treatment	263
		15.4. Our own group of patients with cervical spine kyphosis	270
		16. Conclusion and acknowledgements	278
		Abbreviations.....	279
		Index	281

Foreword

During my long career I had the opportunity to follow and actively support the dynamic development of spinal surgery in our country.

Orthopaedics and especially spinal surgery have recorded a significant upsurge all over the world in a historically short period particularly due to improved diagnostics and development of instrumentation and implants. One of the outcomes of evolution of spinal surgery in the Czech Republic is a unique publication Cervical Spine Trauma.

The Czech specialists have always kept up with the world surgery. One of the first surgeons to perform fusion of the lumbar spine was Eduard Albert (1841–1900) in 1895. His successor in Innsbruck and Vienna, Karel Maydl performed the first laminectomy, that he called resection of the spine, on 22 December 1882. In 1891, Karel Maydl was appointed Head of the Department of Surgery of the Prague University and laid foundations of modern Czech surgery. In 1902, Stanislav Tobiášek began to work at the same Department. Later he opened the first orthopaedic department in Bohemia. He was succeeded by Jan Zahradníček who also dealt in spinal surgery. His activity at the Department marks the beginning of a new era of the Czechoslovak orthopaedic surgery.

After World War II, the efforts in this field focused on development of spinal instrumentation and efficient spine surgery techniques. Harrington in the USA introduced the first comprehensive spinal instrumentation, Roy-Camille in France invented transpedicular implantation of screws and, subsequently, Friedrich Magerl introduced external fixator. It was particularly Magerl who has accelerated the development of spinal surgery as a specialization and who is one of the most prominent personalities in this field. He has based his work on the AO school, founded in 1958, with another outstanding personality M.E. Müller, leading the Department of Orthopaedic Surgery and Traumatology in St. Gallen. This department has hosted most of heads of university clinics from all over Europe over the years. In 1965, I established close cooperation with the Department in St. Gallen.

The seventies of the 20th century witnessed the introduction of CT and later also MRI examination that contributed considerably to further development of di-

agnostics of spinal injuries and classification systems. Magerl improved and developed new techniques of treatment of spinal injuries, including direct osteosynthesis of the *dens axis*, translaminar and transarticular screws. A revolutionary invention was external fixation, later converted to internal fixation, that has been used in various modifications until today. In cooperation with Bernard Jeanneret, Magerl was also involved in development of instrumentation for posterior cervical stabilization. In 1994, he published together with his colleagues a modern pathomorphological AO classification for fractures of the thoracolumbar spine. He has also introduced AO training courses for spinal surgeons that have undoubtedly conducted to standardization of findings and knowledge in the field of spinal surgery.

I had come to understand the big potential for development of the spinal surgery in our country and its importance during my three-month stay at the Department of Orthopaedic Surgery in Paris, headed by Robert Judet. There I met the Judet's colleagues Letournell and Roy-Camille who introduced me into the mysteries of spinal surgery. Another milestone in the development of the Czech spinal surgery was a long-term stay of Otto Vlach in Twin Cities Scoliosis Center in the USA. After he returned home, he laid foundations of modern surgical treatment of scoliosis and other spinal defects here. In 1986, he published a book on treatment of scoliosis based on an extensive textbook by John H. Moe. For a long time the Department of Orthopaedic Surgery in Brno was actually the only institution in Czechoslovakia that dealt exclusively with surgical treatment of scoliosis. Otto Vlach is a top specialist in this field and was the first to teach us about destabilization effects of laminectomy without fixation, that was at that time performed routinely in spinal fractures with a neurological deficit.

After opening the Orthopaedic Department of 3rd Faculty of Medicine, Charles University in Prague, spinal surgery became one of its three main focuses, together with joint replacement and traumatology of the musculoskeletal apparatus. Our model was the Orthopaedic Department in St. Gallen, with Friedrich Magerl at its head. Thanks to our long-term cooperation a number of our colleagues had the opportunity to gain experience there through short fellowships.

In 1991, the Orthopaedic Department of 3rd Faculty of Medicine, Charles University organized a one-day symposium in Prague on “Spinal surgery – new techniques” with active participation of Professor Magerl and B. Janneret and in the same year the Department started to work on a research task under the grant IGA MZ 1771-3 on “Specification of the technique of stabilization of spine”. Under the research program the Department bought modern instruments and implants and at the beginning of 1992 it launched the process of implementation of these new progressive procedures.

The team specialized in spinal surgery at the Department included particularly Martin Krbec, Zdeněk Klézl and Jan Štulík. However, over a certain period spinal surgery was not adequately supported as a specialization and as a result, they left the Department. Zdeněk Klézl left in 1995 for the Orthopaedic Department of the Central Military Hospital in Prague, Martin Krbec was in 1999 appointed Head of the Orthopaedic Department in Brno, where he followed the trend launched by Otto Vlach. In 2009, Martin Krbec became Head of the Orthopaedic Department of 3rd Faculty of Medicine, Charles University in Prague and Zdeněk Klézl a senior spinal surgeon in Derby in United Kingdom. Jan Štulík left in 2001 for the University Hospital Motol in Prague, where he has built in few years an independent Center

for Spinal Surgery, together with his colleagues Tomáš Vyskočil, Petr Šebesta and Jan Kryl.

Thanks to high productivity and top quality of the provided medical care, the Center for Spine Surgery University Hospital Motol has won recognition both in the Czech Republic and abroad. The Department is respected also for its activities in the field of research and development and education.

It is with great satisfaction that I follow the development of spinal surgery, the outcomes of these long-term exceptional efforts in such a highly demanding specialization. The present book summarizes the work of authors of several generations. It is the first comprehensive publication dealing with the issue of “Cervical Spine Trauma” in the Czech literature. Fourteen clinical chapters describe in detail individual injuries at different levels of the cervical spine. The monograph was prepared by a team of experienced authors who supplemented it with a wide range of their own high quality radiological material, as well as a number of instructional schemes. The list of references provides an exhaustive overview of the world literature related to this field.

The presented publication has a high scientific and educational value.

I wish to congratulate the authors.

Oldřich Čech
Professor Emeritus, Charles University

Foreword

Spinal trauma surgery has evolved as a separate subspecialty within a wide range of spinal disorders. In this context, this book is a logical step forward, because it brings together all relevant aspects of cervical spine trauma treatment, following systematically the medical aspects and focusing on the surgical treatment. Although the book is primarily intended for trauma surgeons, it may be useful also to those who specialize in non-traumatic disorders, as it will help them get a better picture of the use of instrumentation, biomechanics of trauma and internal fixation and maximize the chance for a successful treatment of cervical spine injuries.

In this relatively circumscribed field the major inherent problems concerning data evaluation due to acuteness of the patients' condition, distribution of cases among multiple Centers and a highly variable mix of spinal injuries, are well known. This has resulted in production of numerous underpowered and often controversial studies. Hence, a vast majority of textbooks, reviews, guidelines and publications that attempt to synthesize the literature usually conclude that further research is needed and no distinct recommendation can be made. However, treating physicians or surgeons must make prompt therapeutic decisions on a daily basis, regardless of the quality of literature. Therefore the experience of surgeons gained over decades of specialisation in this field, is of extraordinary importance. This book offers a unique body of experience of specialists in the

field of cervical spine trauma to both the future as well as the already established spine surgeons.

As the authors come from the Central Europe, their readership should be aware that the experience expressed in the book may differ from that in other parts of the world. This, however, should not be perceived as limitation of the applicability of the experience but rather as a contribution of the Central European approach to the world literature.

The recent decades have seen an explosion of innovations, significant progress as well as increasing complexity of cervical spine trauma management. Several new surgical techniques and treatment options have been established, that are included in this book. However, due to the continuous medical progress, obviously further changes are already taking place even during the process of publishing of this book, leaving the reader with a "snapshot" of the development of the body of knowledge.

I wish to congratulate the authors on this excellent book which I am sure will make the decisions of surgeons in the everyday practice much easier. The authors, experts in cervical spine trauma care, have used their long-term clinical experience to formulate recommendations that may be helpful in the efforts to provide the patients with the best possible treatment. I hope that you will enjoy this book and believe that it will bring benefit both to you and to your patients.

Frank Kandziora, M.D., Ph.D.

Professor and Chairman

Center for Spinal Surgery and Neurotraumatology
BG-Trauma Hospital, Frankfurt, Germany



Photo © Martin Krpač, TV reporter and photographer, Czech Press Foto 2007

1. Introduction

In the past, spinal surgery was only a marginal discipline at many orthopedic and neurosurgical departments, both in the Czech Republic and abroad. Gradually it has won respect as an independent discipline or at least as a sub-specialization singled out from the mentioned disciplines. In the Czech Republic, the Czech Society of Spinal Surgery was founded in 1999. It associates orthopedic surgeons, neurosurgeons and trauma surgeons involved in the treatment of diseases and injuries of the spine and the spinal cord. The Society has soon become a respected member of the Czech Medical Society of Jan Evangelista Purkyně. It has organized eight annual congresses, developed the concept of the discipline, created the database of spinal operations and a register of spinal cord lesions. The database was also used to categorize spinal surgery departments. Currently, there are 20 of them in the Czech Republic of different categories, of which 3–4 top quality departments are fully comparable with the European clinical and scientific standard. Another achievement in this field is development of a network of spinal injury units dealing with the treatment of patients with spinal cord injuries.

Ten years ago, the concept of spinal surgery as an independent discipline was quite unthinkable. Since then the situation has changed and the experience both in the Czech Republic and abroad proves that this idea is feasible and specialized departments call the tune in further development. Therefore, it seems appropriate to explain the respective concepts in historical consequences.

What is spinal surgery? It is a medical discipline that builds on orthopedic surgery, neurosurgery and, taking into account surgical approaches, also on general surgery. It deals particularly with the operative but also with non-operative treatment of spinal diseases. Surgical treatment of spinal diseases has developed along two basic trends, the orthopedic and neurosurgical one. Spinal surgery aims to link the two trends together, make use of their benefits and ensure further advancement. It may be divided according to three basic criteria, namely anatomical location, diagnosis and type of the surgical intervention. In anatomical terms, the spine is divided into the upper cervical spine and craniocervical junction,

the lower cervical spine, the thoracic spine, the lumbar spine, sacrum and coccyx. In diagnostic terms, it covers injury, degenerative change, deformity, tumor, inflammation or manifestations of a systemic disease; and in surgical terms, it includes a simple resection, internal fixation, bone fusion of the surrounding spinal segments or mobile stabilization.

The remarkable progress in spinal surgery as a separate discipline would be impossible without a parallel development in the field of asepsis, instrumentation, anesthesiology or imaging methods. The first attempts at treatment of spinal injuries that had to do without achievements which we have at our disposal today, are highly admirable. Today it is hard to imagine for instance an operation without electrocoagulation that has considerably reduced both blood loss and duration of surgery.

The book contains 16 chapters focused on the most important information that is essential for treatment of cervical spine injuries. Knowledge of anatomy of the occipitocervical junction, the lower cervical spine and the cervicothoracic junction is crucial for insertion of fixation components into the occipital bone and individual vertebrae. Biomechanical relations are decisive for the extent of spinal fusion and placement of fixation on the anterior, posterior or, if necessary, on both sides of the spine in markedly unstable injuries.

Indication for surgery should be based on a careful clinical examination and the corresponding radiological, CT or MRI findings. The current CT technology provides a reliable image in a few minutes and subsequently reconstructs any bone injury from the head down to the pelvis, including the complicated occipitocervical, cervicothoracic and lumbosacral regions. In patients with neurological deficit, MRI provides a detailed image of spinal cord injury, posterior ligamentous complex, anterior longitudinal ligament and especially of the intervertebral disc.

Knowledge of surgical approaches is essential for treatment of cervical spine injuries. We recommend to perform anterior approaches to the upper cervical spine and cervicothoracic junction always in cooperation with the respective specialists. Injuries most frequently