Spine Surgery

A Case-Based Approach

Bernhard Meyer
Michael Rauschmann
Editors

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Editors
Bernhard Meyer
Department of Neurosurgery
Klinikum rechts der Isar
Technische Universität München
Munich
Germany

Michael Rauschmann
Department of Spine Surgery
Sana Klinikum Offenbach
Offenbach
Germany

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Preface

We are very excited to introduce this new book on spinal surgery, which follows the curriculum of the EUROSPINE basic and advanced diploma courses. The approach we take is a purely case-based one, in which each case illustrates the concepts surrounding the treatment of a given pathology, including the uncertainties and problems in decision-making. The readers will notice that in many instances a lack of evidence for a given treatment exists. So decisions taken are usually not a clearcut matter of black or white, but merely different shades of gray. Probably in a lot of cases, there is often more than one option to treat the patient. The authors were asked to convey this message to the reader, giving him a guidance as what would be accepted within the mainstream. In addition, the reader is provided with the most updated literature and evidence on the topic.

Most of the authors are teachers in the courses of EUROSPINE or other national societies with often vast clinical experience and have given their own perspective and reasoning.

We believe that the readers will profit very much from this variety and bandwidth of knowledge provided for them in the individual chapters. We have given the authors extensive liberty as to what they consider the best solution for their case. It is thus a representative picture of what is considered standard of care for spine pathologies in Europe.

We hope that this book will be an ideal complement for trainees to the courses they take.

Munich, Germany — Bernhard Meyer
Offenbach, Germany — Michael Rauschmann

Contents

Part VII Advanced Module 2: Complications and Management

Contributors

R. Emre Acaroglu Ankara Spine Center, Ankara, Turkey

Mohammad Arabmotlagh Spine Department, Academic University Hospital Sana Klinik Offenbach, Goethe University Frankfurt, Offenbach, Germany

Eleftherios Archavlis Department of Neurosurgery, Universitätsmedizin Mainz, Johannes Gutenberg Universität Mainz, Mainz, Germany

Alkinoos Athanasiou First Department of Neurosurgery, AHEPA University General Hospital, Aristotle University of Thessaloniki, Thessaloniki, Greece

Massimo Balsano UOC Ortopedia e Traumatologia, Regional Spinal Department, AOUI, Verona, Italy

Cédric Y. Barrey Department of Spine and Spinal Cord Surgery, University Hospital Pierre Wertheimer (GHE), Claude Bernard University of Lyon 1, Hospices Civils de Lyon, Lyon, France

Simon Bayerl Department of Neurosurgery, Charitè – Universitätsmedizin Berlin, Berlin, Germany

Lukas Bobinski Department of Orthopedics, Spine Unit, Umeå University Hospital, Umeå, Sweden

Etienne Bourassa-Moreau Oxford University Hospitals NHS Foundation Trust, Nuffield Orthopaedic Centre, Oxford, UK

Adrian T. H. Casey Victor Horsley Department of Neurosurgery, The National Hospital for Neurology and Neurosurgery, Queen Square, London, UK

Jens Castein Zentrum für Wirbelsäulenchirurgie und Neurotraumatologie, BG Unfallklinik Frankfurt am Main, Frankfurt am Main, Germany

Yann Philippe Charles Service de Chirurgie du Rachis, Hôpitaux Universitaires de Strasbourg, Strasbourg, France

Jens Conrad Department of Neurosurgery, Universitätsmedizin Mainz, Johannes Gutenberg Universität Mainz, Mainz, Germany

Marcus Czabanka Department of Neurosurgery, Charité – Universitätsmedizin Berlin, Berlin, Germany

Julius Dengler Department of Neurosurgery, Charitè – Universitätsmedizin Berlin, Berlin, Germany

Michael E. Doany Department of Orthopedics, Stony Brook University, Stony Brook, NY, USA

John M. Duff Department of Clinical Neurosciences, University Hospital of Lausanne, CHUV, Lausanne, Switzerland

A. El Rahal Department of Spine and Spinal Cord Surgery, University Hospital Pierre Wertheimer (GHE), Claude Bernard University of Lyon 1, Hospices Civils de Lyon, Lyon, France

V. Fiere Department of Spine Surgery, Mermoz Private Hospital, Lyon, France

Christoph Fleege Spine Department, Orthopaedic University Hospital Friedrichsheim, Frankfurt, Germany

Jörg Franke Department of Orthopedics, Klinikum Magdeburg, Magdeburg, Germany

Martin Gehrchen Spine Unit, Department of Orthopaedic Surgery Rigshospitalet, University of Copenhagen, Copenhagen, Denmark

Jens Gempt Department of Neurosurgery, Klinikum rechts der Isar, Technische Universität München, Munich, Germany

Angelika Gutenberg Department of Neurosurgery, Universitätsmedizin Mainz, Johannes Gutenberg Universität Mainz, Mainz, Germany

Sleiman Haddad Department of Orthopaedic Surgery, Spine Unit, University Hospital Vall d'Hebron, Barcelona, Spain

Spine Surgery, Hospital Universitari Vall d'Hebron, Spine Institute Hospital Quiron, Barcelona, Spain

Sebastian Hartmann Department of Neurosurgery, Medical University Innsbruck, Innsbruck, Austria

Nils Hecht Department of Neurosurgery, Charité – Universitätsmedizin Berlin, Berlin, Germany

Sebastian Ille Department of Neurosurgery, Klinikum rechts der Isar, Technische Universität München, Munich, Germany

Max Jägersberg Department of Neurosurgery, University Medical Center Mainz, Mainz, Germany

Dezsö Jeszenszky Department of Spine Surgery, Schulthess Klinik, Zürich, Switzerland

Frank Kandziora Zentrum für Wirbelsäulenchirurgie und Neurotraumatologie, Berufsgenossenschaftliche Unfallklinik Frankfurt am Main, Frankfurt am Main, Germany

Sven R. Kantelhardt Department of Neurosurgery, Universitätsmedizin Mainz, Johannes Gutenberg Universität Mainz, Mainz, Germany

David Kieser University of Otago, Department of Orthopaedic Surgery and Musculoskeletal Medicine, Christchurch School of Medicine, Christchurch, New Zealand

Esat Kiter Pamukkale University, Department of Orthopedics, Denizli, Turkey

Sandro M. Krieg Department of Neurosurgery, Klinikum rechts der Isar, Technische Universität München, Munich, Germany

Jesús Lafuente Servicio de Neurocirugía, Hospital del Mar, Universidad de Barcelona, Barcelona, Spain

Ulf Liljenqvist Department for Spine Surgery, St. Franziskus Hospital, Münster, Germany

Markus Loibl Department of Spine Surgery, Schulthess Klinik, Zürich, Switzerland

Rodolfo Maduri Department of Clinical Neurosciences, University Hospital of Lausanne, CHUV, Lausanne, Switzerland

Ioannis Magras First Department of Neurosurgery, AHEPA University General Hospital, Aristotle University of Thessaloniki, Thessaloniki, Greece

Vasiliki Magra Plastic Surgery Department, Lister Hospital, East & North Hertfordshire NHS Trust, Hertfordshire, UK

Antonia Matamalas Department of Orthopaedic Surgery, Spine Unit, University Hospital Vall d'Hebron, Barcelona, Spain

Bernhard Meyer Department of Neurosurgery, Klinikum rechts der Isar, Technische Universität München, Munich, Germany

Hanno S. Meyer Department of Neurosurgery, Klinikum rechts der Isar, Technische Universität München, Munich, Germany

S. Michalitsis Department of Orthopedics, Klinikum Magdeburg, Magdeburg, Germany

Wouter A. Moojen Haaglanden Medical Center, The Hague, The Netherlands

Haga Teaching Hospital, The Hague, The Netherlands

Leiden University Medical Center, Leiden, The Netherlands

Stefano Negri UOC Ortopedia e Traumatologia, Regional Spinal Department, AOUI, Verona, Italy

Susana Núñez-Pereira Spine Unit, Hospital Universitario Donostia, Donostia/San Sebastián, Spain

Nusret Ok Pamukkale University, Department of Orthopedics, Denizli, Turkey

Haiko Pape Department of Neurosurgery, Klinikum rechts der Isar, Technische Universität München, Munich, Germany

Juan D. Patino Neurosurgery Department, Hospital de la Santa Creu i Sant Pau, Barcelona, Spain

Ferran Pellisé Department of Orthopaedic Surgery, Spine Unit, University Hospital Vall d'Hebron, Barcelona, Spain

Andreas Pingel Zentrum für Wirbelsäulenchirurgie und Neurotraumatologie, BG Unfallklinik Frankfurt am Main, Frankfurt, Germany

George K. Prezerakos Victor Horsley Department of Neurosurgery, The National Hospital for Neurology and Neurosurgery, Queen Square, London, UK

Michael Rauschmann Department of Spine Surgery, Sana Klinikum Offenbach, Offenbach, Germany

Jeremy J. Reynolds Oxford University Hospitals NHS Foundation Trust, Nuffield Orthopaedic Centre, Oxford, UK

Marcus Richter Spine Center, St. Josefs-Hospital, Wiesbaden, Germany

Florian Ringel Department of Neurosurgery, Universitätsmedizin Mainz, Johannes Gutenberg Universität Mainz, Mainz, Germany

David Rodríguez-Rubio Servicio de Neurocirugía, Hospital del Mar, Universidad de Barcelona, Barcelona, Spain

Dominique A. Rothenfluh Oxford University Hospitals NHS Foundation Trust, Nuffield Orthopaedic Centre, Oxford, UK

Yu-Mi Ryang Department of Neurosurgery, Klinikum rechts der Isar, Technische Universität München, Munich, Germany

Philipp Schleicher Zentrum für Wirbelsäulenchirurgie und Neurotraumatologie, Berufsgenossenschaftliche Unfallklinik Frankfurt am Main, Frankfurt am Main, Germany

Matti Scholz Zentrum für Wirbelsäulenchirurgie und Neurotraumatologie, Berufsgenossenschaftliche Unfallklinik Frankfurt am Main, Frankfurt am Main, Germany

Alpaslan Senkoylu Gazi University, Ankara, Turkey

Ehab Shiban Department of Neurosurgery, Klinikum rechts der Isar, Technische Universität München, Munich, Germany

Andrei Slavici Department of Spine and Reconstructive Orthopedic Surgery, Sana Klinikum Offenbach, Offenbach am Main, Germany

F. Solla Department of Pediatrics Orthopedics, Lenval Hospital, Nice, France

Michael Stoffel Department of Neurosurgery, Helios Klinikum Krefeld, Krefeld, Germany

Enrico Tessitore Department of Neurosurgery, Faculty of Medicine, University of Geneva, Geneva, Switzerland

Claudius Thomé Department of Neurosurgery, Medical University Innsbruck, Innsbruck, Austria

Dimitri Tkatschenko Department of Neurosurgery, Charitè – Universitätsmedizin Berlin, Berlin, Germany

Aurélie Toquart Department of Spine and Spinal Cord Surgery, University Hospital Pierre Wertheimer (GHE), Claude Bernard University of Lyon 1, Hospices Civils de Lyon, Lyon, France

Sven Kevin Tschoeke Department of Spine Surgery, Klinikum Dortmund gGmbH, Dortmund, Germany

Anja Tschugg Department of Neurosurgery, Medical University Innsbruck, Innsbruck, Austria

Peter Vajkoczy Department of Neurosurgery, Charitè – Universitätsmedizin Berlin, Berlin, Germany

N. A. van der Gaag Haaglanden Medical Center, The Hague, The Netherlands

Haga Teaching Hospital, The Hague, The Netherlands

Lars Wessels Department of Neurosurgery, Charité Universitätsmedizin Berlin, Berlin, Germany

Maria Wostrack Department of Neurosurgery, Klinikum rechts der Isar, Technische Universität München, Munich, Germany

Ulas Yildiz Zentrum für Wirbelsäulenchirurgie und Neurotraumatologie, BG Unfallklinik Frankfurt am Main, Frankfurt, Germany

Caglar Yilgor Acibadem Mehmet Ali Aydinlar University School of Medicine, Department of Orthopedics and Traumatology, Istanbul, Turkey

Kimia Rahnama Zand Clinical Neurophysiology, Intraoperative Neuromonitoring, Hospital Universitari Vall d'Hebron, Spine Institute Hospital Quiron, Barcelona, Spain

Anna Zdunczyk Department of Neurosurgery, Charité Universitätsmedizin Berlin, Berlin, Germany

Part I

Basic Module 1: Conservative Therapy

Treatment for Acute, Subacute and Chronic Low Back Pain

1

Ehab Shiban and Bernhard Meyer

1.1 Introduction

Low back pain (LBP) has become the leading cause for living with disability in the world [3]. In an analysis of two national surveys in the United States one third of U.S adult reported having LBP at least for 1 day during the last 3 months [4]. In a national German survey 25% of women and 17% of men reported having LBP lasting for at least 3 months during the last year [5]. LBP causes also a great financial burden to the health care system with high direct costs related to treatment as well as indirect costs due to sick leave or diminished productivity.

In general LBP is classified and treated based on duration of symptoms, potential cause, presence or absence of radicular symptoms and corresponding radiological abnormalities [2]. Thereby specific LBP is to be distinguished from nonspecific LBP. Specific LBP has a detectable somatic cause and treatment thereof will probably lead to pain reduction (e.g. herniated disc, spinal canal stenosis, infection, vertebral metastasis etc.). On the other hand, in nonspecific LBP treatment is mainly symptomatic [1]. Acute LBP lasts less than 1 month, subacute LBP lasts between 1 and 3 months and chronic LBP lasts more than 3 months. In 2017 the German and North American national societies each published revised guidelines for the treatment of non-specific LBP [1, 2]. Thereby the initial evaluation, necessity of further laboratory or imaging evaluation as well as the efficacy of treatment modalities are discussed.

This chapter will outline these guidelines. Moreover, the different treatment modalities are discussed with regards to their efficacy and level of evidence. At the end of this chapter the readers should be able correctly manage patients with nonspecific LBP.

The aim of the presented case is to illustrate the management algorithms and treatment allocation for patients with chronic non-specific LBP.

1.2 Case Description

A 48 year-old female patient presented with a 3-day history of exacerbated LBP. Pain exacerbation was following lifting her 3 year-old son. The patient reported having episodic LBP for the last 18 months. She already had magnetic resonance imaging 6 months prior illustrating slight degenerative disc changes of the lower spine (Fig. 1.1). She already had acupuncture and massages that help reduce the pain intermittently. She also reported having facet joint

E. Shiban (✉) · B. Meyer
Department of Neurosurgery, Klinikum rechts der Isar, Technische Universität München, Munich, Germany
e-mail: Ehab.shiban@tum.de

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Fig. 1.1 Magnetic resonance imaging of the lumbar spine. Slight degenerative changes in L5/S1 are noted. No disc herniation or spinal canal stenosis

infiltration therapy 2 months prior to presentation that resulted in markedly reduced pain for 6 weeks. Upon presentation she was on 800 mg Ibuprofen twice daily for the last 6 months. Otherwise she was very healthy without any other preexisting conditions. She had a normal physical examination. The patient was initially managed with intravenous Piritramide and oral Metamizole. Because there were no new symptoms, there was no need for a new MRI. Dynamic radiographs ruled out apparent instability (Fig. 1.2). In order to facilitate pain relief bilateral facet joint infiltration to L4/5 and L5/S1 were performed. Thereafter the pain was markedly reduced and the intravenous pain medication was stopped. The patient was then discharged with oral Tramadol (50 mg) twice daily for 2 weeks and was referred to multidisciplinary biopsychosocial rehabilitation.

1.3 Discussion of the Case

1.3.1 Why Were Things Done This Way

The patient in the above mention clinical vignette was suffering form non-specific low back pain. MRI imaging 6 months prior to presentation not did show any specific pathologies and dynamic radiograph ruled out apparent instability. Because there were no "red flags" there was also no need for any new or further diagnostic imaging. Initial short-term intravenous opioids were given to facilitate rapid pain reduction. Because the patient already had positive experience with facet joint infiltration, we decided to repeat them and discharge the patient with a short period of oral opioids and referral to a multidisciplinary rehabilitation program.

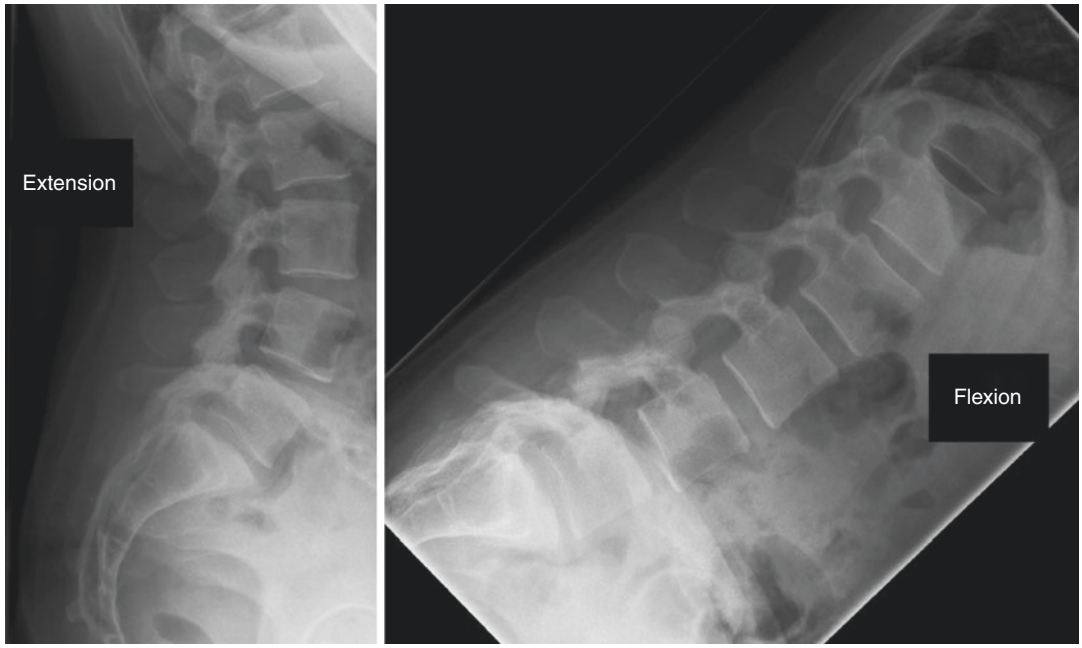

Fig. 1.2 Dynamic radiographs (Flexion/Extension) of the lumbar spine. No signs are apparent instability are noted

1.3.2 Were They in Accordance with the Literature Guidelines

In 2017 both the German [1] and the North American [2] national societies have each published a new version of the guidelines for the treatment of LBP. Both guidelines are very similar and recommend that for patients with acute or subacute LBP without any "red flags" (Table 1.1) clinicians should avoid unnecessary tests and treatments because in most cases the pain will resolved in time without a specific treatment.

Initially it is very important to explain to the patient that LBP is extremely common, the prognosis is generally very good and that pain does not necessarily mean organ damage. At first nonmedical treatment with or without pain medication should be recommended. Although there are some general recommendations for medical treatment (Table 1.2), no clear recommendations can be made with regards to any specific treatment modality because the treatment effects are small and often show no clear benefit when compared to controls (Tables 1.3 and 1.4). If at this stage any psychosocial risk factors are identified or are already known, these risk factors need to be incorporated in the counseling and should be adequately addressed [8].

Table 1.1 "Red flags" in the assessment of low back pain

Fracture/osteoporosis: severe to moderate trauma cases; minimal trauma in the elderly; systemic steroid use
Infection: fever, shivering; i.v. Drug abuse; immunocompromised**,** recent infiltration therapy to the spine
Neurological compromise: cauda-equina syndrome; muscle weakness; genital hypoesthesia; micturition problems
Tumor/metastases: History of cancer; B-symptoms (fever, night sweats, and weight loss); pain exacerbation in prone position

After 12 weeks of pain and restrictions in daily activity despite treatment, a multidisciplinary assessment and treatment should be done. The goal is to empower patients through acceptance-based strategies to actively and consciously shape their lives despite the pain. Thereby multimodal behavioral therapy strategies seem to be most effective. In a Cochrane review of 41 studies and 6858 patients the

Table 1.2 General consideration for medical treatment of LBP

Non-opioid pain medication	
Non-steroidal antiphlogistics (NSAIDs)	1. No clinical superiority of any specific NSAIDs 2. No evidence for parental use, therefore oral application are recommended 3. Daily dose of 1.2 g of Ibuprofen, 100 mg of Diclofenac or 750 mg of Naproxen should not be exceeded. However if the effect is insufficient, the dose may be briefly increased to 2.4 g of Ibuprofen, 150 mg of Diclofenac or 1.25 g of Naproxen 4. Concomitant administration of Proton-pump Inhibitors is recommended
COX-2 inhibitors	1. If NSAIDs are contraindicated 2. Contraindicated in patients with coronary heart disease, stroke, hart failure or peripheral artery disease
Metamizole	1. If NSAIDs are contraindicated 2. Caution in patients with concomitant long-term Acetaminophen treatment (causes platelet aggregation inhibition) 3. Agranulocytosis is a rare but very severe adverse effect
Paracetamol	Two high level RCTs did not show any benefit compered to placebo, therefore administration is not recommended anymore [9]
Opioids	1. The opioid therapy should be regularly reevaluated, in acute LBP 4 weeks at the latest, in chronic LBP after 3 months at the latest 2. Opioids are to be used for the long-term treatment of chronic LBP only in the context of multimodal behavioral therapy strategies 3. Transdermal opioids should not be used to treat acute and subacute LBP
Muscle relaxants	Not recommended for LBP
Antidepressants	Only recommended in the presence of comorbid depression or sleep disorder
Antiepileptic drugs	Not recommended for LBP
Herbal medicine	1. Taking into account the side effects and contraindications (similar to those of the NSAIDs), a therapy trial with willow bark can be undertaken as part of an overall therapeutic concept 2. Due to the lower level of evidence for the use of devil's claw is not recommended.
Topical applications	1. Moderate level evidence exist for the use of capsaicin 2. Topical NSAIDs are not recommended
Intravenous, intramuscular or subcutaneous applications	Given the effectiveness of a wide range of oral analgesics the use of injections of painkillers, local anesthetics, etc. due to side effects and complications is not recommended for LBP

Table 1.3 Medical treatment vs. placebo (acute low back pain)

	Magnitude of effect	Strength of evidence
Acetaminophen	No effect	Low (1 RCT)
NSAIDs	Small	Moderate (5 RCTs)
Muscle relaxants	Small	Moderate (5 RCTs)
Systemic corticosteroids	No effect	Low (2 RCTs)

Modified from [2]

Table 1.4 Non-medical treatment vs. sham or usual treatment (acute & subacute low back pain)

Intervention	Magnitude of Effect	Strength of evidence
Heat wrap vs. placebo	Moderate	Moderate (4 RCTs)
Exercise vs. usual care	No effect	Low (6 RCTs)
Acupuncture vs. sham acupuncture	Small effect	Low (2 RCTs)
Massage vs. sham massage	1 week: Moderate 5 weeks: No effect	Low (2 RCTs)
Spinal manipulation vs. inert treatment	No effect	Low (3 RCTs)
Spinal manipulation vs. sham treatment	Small	Low (2 RCTs)

Modified from [2]

Table 1.5 Non-medical treatment vs. sham or usual treatment (chronic low back pain)

Intervention	Magnitude of effect	Strength of evidence
Exercise vs. no exercise	Small	Moderate (19 RCTs)
Exercise vs. usual care	Small	Moderate (18 RCTs)
Motor control exercise	Moderate	Low (2 RCTs)
Tai chi vs. wait-list or no tai chi	Moderate	Low (2 RCTs)
Yoga vs. usual care	Moderate	Low (1 RCTs)
Yoga vs. education	No effect	Low (5 RCTs)
Mindfulness-based stress reduction vs. usual care	Improved	Moderate (3 RCTs)
Progressive relaxation vs. wait list control	Moderate	Low (3 RCTs)
Electromyography biofeedback vs. wait-list control or placebo	Moderate	Low (3 RCTs)
Operant therapy vs. wait list	Small	Low (3 RCTs)
Cognitive behavioral therapy vs. wait-list control	Moderate	Low (3 RCTs)
Multidisciplinary rehabilitation vs. usual care	Small	Moderate (9 RCTs)
Multidisciplinary rehabilitation vs. no multidisciplinary rehabilitation	Moderate	Low (3 RCTs)
Acupuncture vs. sham acupuncture	Moderate	Low (9 RCTs)
Acupuncture vs. no acupuncture	Moderate	Moderate (4 RCTs)
Massage vs. usual care	No effect	Low (1RCT)
Spinal manipulation vs. sham treatment	No effect	Low (4 RCTs)
Spinal manipulation vs. inert treatment	Small	Low (7 RCTs)
Ultrasound vs. sham ultrasound	No effect	Low (5 RCTs)
Ultrasound vs. no ultrasound	No effect	Low (5 RCTs)
TENS vs. sham treatment	No effect	Low (4 RCTs)
Laser-therapy vs. sham laser	Small	Low (3 RCTs)
Kinesio taping vs. sham taping	No effect	Low (2 RCTs)

Modified from [2]

Table 1.6 Medical treatment vs. placebo (chronic low back pain)

Intervention	Magnitude of effect	Strength of evidence
NSAIDs	Small to moderate	Moderate (6 RCTs)
Strong opioids	Small	Moderate (10 RCTs)
Tramadol	Moderate	Moderate (7 RCTs)
Tetrazepam	Small	Low (2 RCTs)
Opioids: buprenorphine or sublingual	Small	Moderate (7 RCTs)
Antidepressants	No effect	Low (2 RCTs)
SSRI	No effect	Moderate (3 RCTS)
Duloxetine	Small	Moderate (3 RCTs)

Modified from [2]

superiority of multidisciplinary biopsychosocial rehabilitation compared to usual care and physical treatment was illustrated [7]. Otherwise like in acute and subacute LBP also in chronic LBP there are no clear recommendations for a specific medical or non-medical treatment modality because the treatment effects are small and often show no clear benefit when compared to controls (Tables 1.5 and 1.6).

1.3.3 Invasive Treatment Options

1.3.3.1 Percutaneous Therapy

There is insufficient evidence to support the use of injection therapy in subacute and chronic low-back pain [10]. However, the heterogeneity of the included patient groups, the small number of patients in the studies, the frequent lack of differentiation between specific and nonspecific causes of LBP, and inconsistent control interventions make the ability to identify specific subgroups that might benefit from a percutaneous procedure very difficult [6].

1.3.3.2 Surgery

Because most surgical studies are performed on patients with specific LBP, there are is no data available for the use of surgery in acute and chronic non-specific LBP.

Clinical Pearls

- Acute or subacute low back pain without any "red flags" need to be reassured that in most cases the pain will resolve in time and therefore potentially harmful and costly tests and treatments should be avoided
- Patients with acute, subacute or chronic low back pain should be advised to remain active as tolerated and not to avoid daily activity
- Both medical and non-medical treatment options show small improvement in pain and often fail to demonstrate clear benefits compared to controls
- There are almost no differences in recommended therapies when studied in head-to-head trials. Therefore, recommendations should primarily be guided by the patient's preferences taking into consideration to minimize harms, such as long-term opioids

Editorial Comment

The use of Facet Joint Infiltrations in this case was thus not in accordance with guidelines in a strict sense, but acceptable due to the rapid pain relief provided by the steroids.

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2 Indications for Emergency Surgical Treatment

Max Jägersberg and Enrico Tessitore

2.1 Introduction

Indications for emergency surgical treatment in degenerative spinal conditions are limited to those where a delay in surgical management may lead to potentially catastrophic and irreversible sequelae. Indeed, those conditions are rarely encountered during clinical practice. The most typical scenarios in the thoraco-lumbar region are cauda equina syndrome (CES) and progressive radicular motor deficit (PRMD), both primarily caused by degenerative lumbar pathology. Early surgical treatment may influence the partial or full recovery and the long-term outcome of concerned patients.

CES is a rare condition where the majority of cauda equina nerve roots are suddenly compressed with sudden loss of motor function, of sensation in the saddle area, of sphincter (bladder and/or bowel) and sexual function [1]. PRMD is an analogous pathological condition where patients present with a progressive motor deficit in lower limbs, related to solitary or double nerve root involvement. The typically encountered clinical type of PRMD is *foot drop* due to L5 and/or L4 nerve root compression. The severity of motor deficit of PRMD is graded by means of the manual muscle testing (MMT) according to the Medical Research Council Scale (Table 2.1) [2].

In most of the cases, both CES and PRMD are caused by an acute disc prolapse compressing the nerve roots, especially if the onset of symptoms is sudden. Nevertheless, other degenerative disorders such as synovial cysts, lumbar stenosis, spondylolisthesis and other compressive pathology (e.g. infections, tumors) can cause the neurological deficit. MRI should be the radiologic imaging of choice since it can not only confirm compression of spinal nerve structures, but also define the underlying pathology. Additional radiographs, with dynamic flexion and extension images and CT might be added if the spinal morphology as encountered on MRI demands for this.

The aim of this chapter is to illustrate via two cases the surgical management of CES and PMRD patients, outlining indication and timing for surgery as well as discussing the evidences in the literature.

Table 2.1 Manual Muscle Testing (MMT) according to the Medical Research Council scale of muscle strength [2]

0	No contraction
1	Flicker or trace of contraction
2	Active movement, with gravity eliminated
3	Active movement against gravity
4	Active movement against gravity and resistance
5	Normal power

M. Jägersberg (✉)
Department of Neurosurgery, University Medical Center Mainz, Mainz, Germany
e-mail: max.jaegersberg@unimedizin-mainz.de

E. Tessitore
Department of Neurosurgery, Faculty of Medicine, University of Geneva, Geneva, Switzerland

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2.2 Case Description

2.2.1 Case 1

A 39 years old male was admitted to a tertiary hospital complaining of right sciatic pain without neurological deficit for 10 days. A medical therapy with pain killers (NSAID drugs) was prescribed and the patient discharged. Five days later, he was admitted in our emergency department complaining of acute onset of bilateral foot distal weakness, associated with perineal loss of sensation, urinary retention and constipation.

The neurological exam showed a L4 paraplegia with bilateral L5-S1 weakness (MMT 1/5), sacral (S1-S5) hypoesthesia, and urinary retention. The patient was catheterized and sent to MRI. The MRI showed a L3-L4 disc prolapse in the context of a congenital and acquired multiple level lumbar stenosis. The herniation compressed the cauda equina and the canal sagittal diameter was dramatically reduced (Fig. 2.1).

The patient was immediately brought to OR for emergency surgical decompression. Surgery consisted of posterior midline approach with L3-L4 flavectomy, L4 right laminectomy and contralateral undercutting, sequestrectomy and microdiscectomy. Surgery was uneventful and the patient admitted to the recovery room.

Then, the patient was sent to a specialized center for rehabilitation. He underwent physical therapy, ergo-therapy, vector physical therapy, swimming, and he received psychological support. Sphincter deficits were treated with anticholinergic drugs, self-catheterization, and manual rectal clear. The patient was discharged after 2 months and ambulatory physical therapy was prescribed to him.

A one-year postoperative MRI (Fig. 2.2) showed no more disc herniation and a persistent congenital and acquired lumbar stenosis. The patient was able to walk 1 km with crutches. He was still performing self-catheterizations and manual rectal clear 2 times/day. Persistent neurogenic perineal pain was treated by pregabalin.

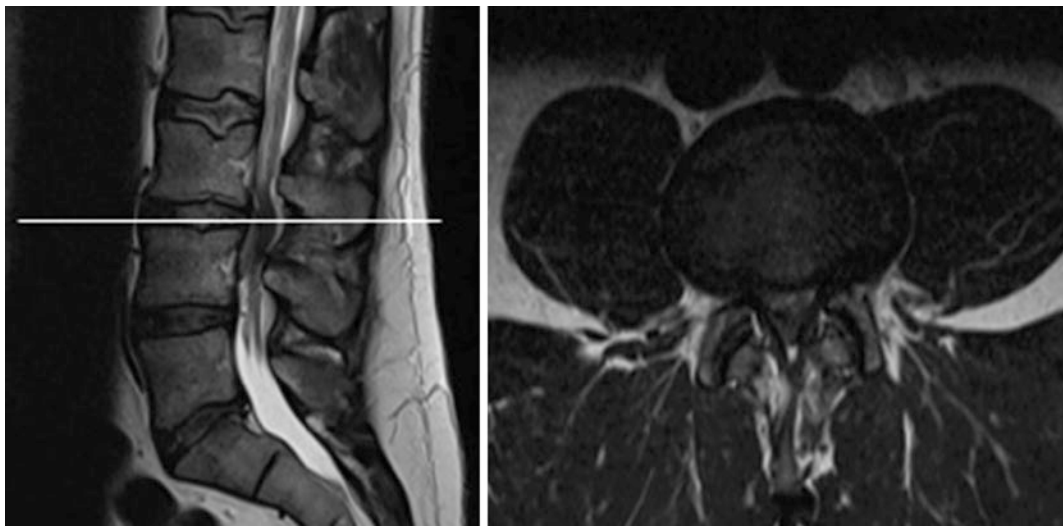

Fig. 2.1 Sagittal (left) and axial (right) MRI showing a large, median and downward migrated disc fragment at L3-L4 level, with cauda equina compression

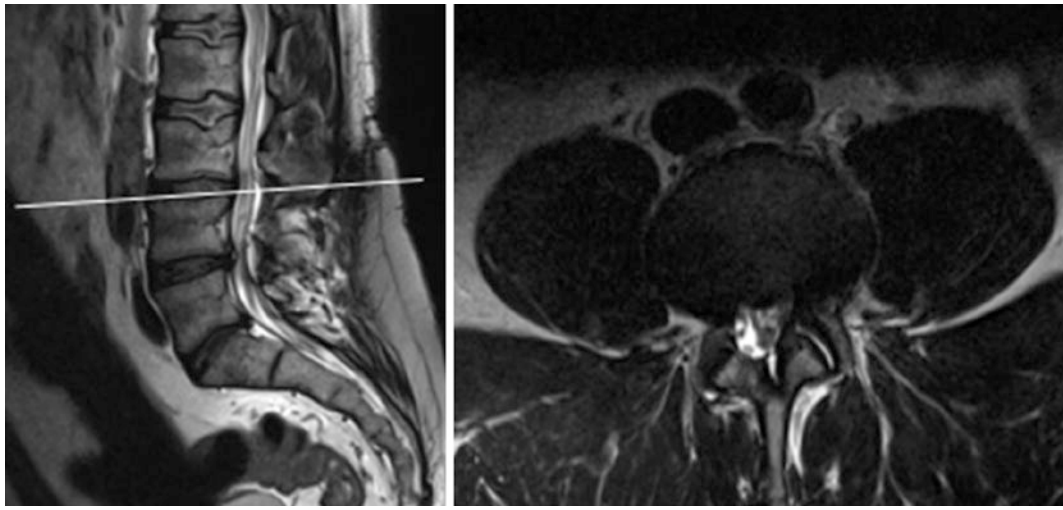

Fig. 2.2 Sagittal (left) and axial (right) 1 year post-operative MRI showing absence of recurrent disc herniation and a complete nerve roots' decompression

2.2.2 Case 2

A 62 years old male patient consulted with left irradiating leg pain into the foot and associated inability to dorsiflex the left ankle. Onset had been 3 months prior to presentation, without injury or brisk movement. No bladder or bowel problems were reported.

Clinical examination revealed a motor deficit MMT 3/5 of both extensor hallucis longus and tibialis anterior muscles. The patient showed the characteristic foot drop steppage gait. Straight leg test was negative. Mechanical back pain testing was low.

The clinical pattern was in line with the radiologic finding of compression of the left L4 and L5 nerve roots, caused by a synovial cyst of the left L4/5 zygoapophyseal joint and by spondylosis and grade I degenerative spondylolisthesis with consecutive stenosis of the L5 recess (Fig. 2.3).

Because no major instability criteria were evident, microsurgical decompressive surgery was advocated and carried out 10 days later. A left L5 hemilaminectomy, cyst removal, and L4 and L5 nerve root decompression were carried out without complications.

Following surgery, the patient was relieved from leg pain. However, he did not observe improvement of muscle strength. Postoperative MRI was carried out but did not show residual nerve root compression (Fig. 2.4). An ankle-foot orthosis was prescribed, but the patient did not see any functional benefit from it.

The surgical result (relief from leg pain, foot drop persistence, MMT 3/5) remained unchanged at follow-up at 3 months, 1 year and 2 years following surgery. Repeated electromyography and nerve conduction studies confirmed an L5 nerve root damage that appeared permanent.

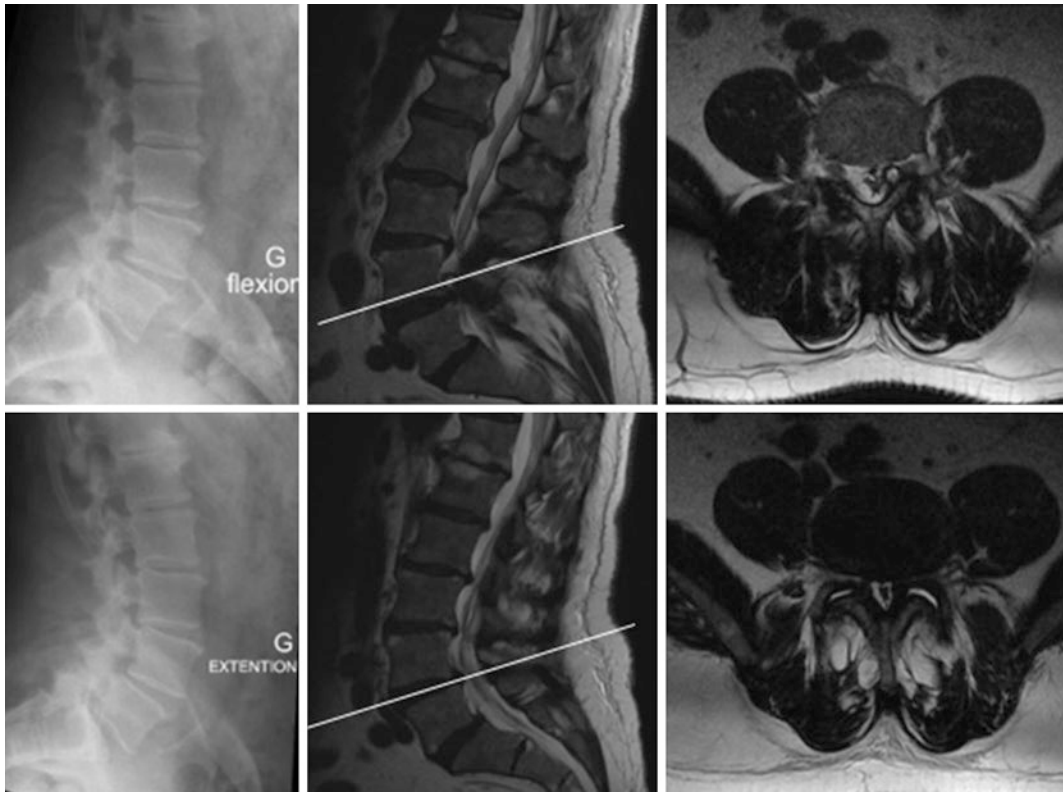

Fig. 2.3 Preoperative dynamic radiographs in flexion and extension, showing minor spondylolisthesis between L4/L5 and L5/S1, without dynamic component. T2-weighted MRI in sagittal and axial planes showing radiologic compression of the left L4 nerve root by synovial cyst formation, left L5 nerve root compression by spondylosis and spondylolisthesis with consecutive recess stenosis

2.3 Discussion of the Cases

2.3.1 Case 1

This case illustrates a typical clinical scenario of CES related to a disc prolapse.

In this particular case, symptoms started in form of severe sciatic pain few days before the installation of CES. The surgical decompression was immediately performed. Time to decompression is the best described outcome predictor in CES. Ahn *et al.* performed a meta-analysis to determine the correlation between timing of decompression and clinical outcome in 322 patients [3]. Significant differences were found in resolution of sensory and motor deficits as well as urinary and rectal function in patients treated within 48 h compared with those treated more than 48 h after onset of symptoms.

In that specific case, despite the fact that the treatment was performed according to the literature guidelines, the patient kept some sequelae of CES at 1 year time follow-up. This demonstrate how this condition may be disabling even though correctly managed.

Contrary to the well-known and studied prevalence and outcome of motor and sensitive sequelae, few data are available on the long-term outcome of micturition, defecation and sexual function after spinal surgery for CES. A study from a Dutch group clearly demonstrated that dysfunction of micturition, defecation and sexual functions are still highly prevalent in a large number of CES patients even years postoperatively [4].

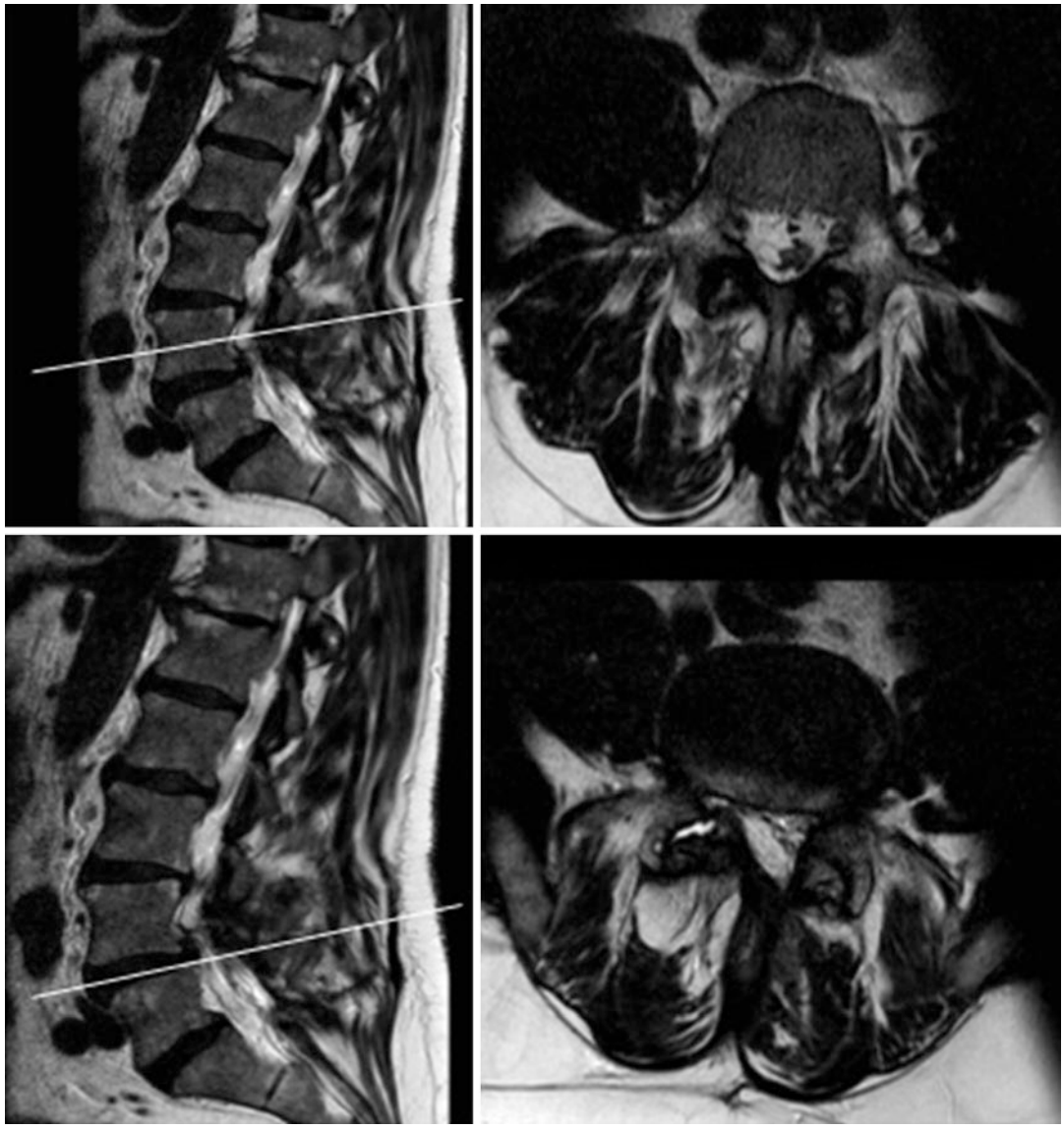

Fig. 2.4 Postoperative T2-weighted MRI in sagittal and axial planes showing effective decompression of both nerve roots by resection of the synovial cyst and recessotomy

2.3.2 Case 2

This chapter covers the emergency situation of severe motor deficit attributable to degenerative spinal disorders at the example of the descriptive symptom *foot drop*. The first step in the management of this scenario is to rule out alternative causes of foot drop (peroneal nerve palsy, brain lesions, spinal cord lesions, MS, polyneuropathy, etc.). A thorough clinical examination and radiologic workup will allow to determine if lumbar degenerative disorder can be responsible or not.

Assessment of motor deficit follows the manual muscle testing (MMT) according to the Medical Research Council Scale (Table 2.1) [2]. It should be mentioned that several studies define foot drop as MMT of less than 3 (i.e. 2, 1 or 0), and "good" recovery if a postoperative MMT of 3 is achieved. In contrast, our case presentation shows well that MMT 3 effectively remains a

Table 2.2 Probability estimates of postoperative motor recovery to strength ≥3 or ≥4 MMT according to Takenaka et al. [8]

	Predictors		Outcome	
Frequency (n_{total} = 102)	Pre tibialis anterior muscle strength	Duration (days)	Post tibialis anterior muscle strength ≥3	Post tibialis anterior muscle strength ≥4
31.4% (n = 32)	2 or 3−	≤ 30	96.9%(n = 31/32)	87.5% (n = 28/32)
33.3% (n = 34)	2 or 3−	> 30	61.7% (n = 21/34)	41.2% (n = 14/34)
14.7% (n = 15)	0 or 1	≤ 30	53.3% (n = 8/15)	46.7% (n = 7/15)
20.6% (n = 21)	0 or 1	> 30	14.3% (n = 3/21)	9.5% (n = 2/21)

foot drop, hence, it should not be considered a good recovery result.

Strong evidence of the superiority of decompressive surgery over conservative treatment for PRMD in the literature is sparse. One explanation for this is the difficulty to perform a randomized controlled trial on this issue – MMT3 or less or progressive deficit are considered absolute indications for surgery, [5] since deficits of this importance as potential final outcome render conservative strategies inappropriate for clinicians and patients. Foot drop is a severe handicap for daily live and the general paradigm to perform surgical decompression of neural structures to reduce ongoing compressive secondary damage has every reason to be applied here as long as no opposed evidence is published.

Overdevest *et al.* have published a subanalysis of 150 patients with sciatic pain and PRMD [6]. The data was taken from a formed subgroup of the prospective randomized controlled Sciatica Trial of Peul *et al.* – a study designed to analyze surgery versus prolonged conservative treatment for radicular pain, independent from PRMD [7]. The authors of the former found a significantly faster recovery of motor deficit following surgery, but no remaining difference between motor function recovery of the surgical and the conservative arms of the sub-group 1 year after randomization. The original study of Peul *et al.* had excluded patients with MMT less than 3 for the reason mentioned above, hence the collective of Overdevest *et al.* contained only patients with MMT 3 or 4, of which patients with MMT 4 showed better recovery. Even if the study did not show time to surgery as a factor for motor recovery, it must be mentioned that this interval was fairly long, 11 weeks in average due to the design of the original work, and it can be argued that faster surgery might have further improved the surgical results. This is strengthened by retrospective studies that focus on preoperative MMT and time to surgery as factors influencing recovery [8, 9]. Elder patient age and etiology other than soft disc hernia are also considered negative predictive factors [8]. On the basis of the analysis of their retrospective work on 102 patients with foot drop due to lumbar degenerative disorder, Takenaka *et al.* have published a decision support tool that indicates, with reference to the respective preoperative MMT and time to surgery, the potential of recovery following surgery (Table 2.2) [8].

The advantage of surgery might become more difficult to advocate when no nerve root pain is present upon presentation, since the absence of leg pain takes out the best reproducible effect of surgery, leg pain reduction. Significant improvement after surgery in painless cases was nonetheless observed in 65% of patients in one retrospective work dedicated to painless foot drop of 20 patients [10].

The available data point on the effect of surgery and furthermore on the importance of time to surgery. Hence, it is a logic approach to con-

sider that the earlier the presentation to the surgeon, the higher the benefit from early or urgent surgery. That is, a patient with MMT 3 since 6 h is more urgent than a patient with MMT 2 since 3 months. In our institution, patients with acute onset of MMT 3 or less or progressive deficit are operated the same day.

2.4 Conclusions and Take-Home Messages

Early surgical decompression for CES or PRMD such as foot drop, if attributable to spinal disorder, remains the standard of care at date. Urgent surgery in less than 48 h should be advocated unless in exceptional cases. Even partial functional recovery will make a difference for every day life for these patients. Persistent sexual and urinary dysfunction should not be trivialized and will require close follow-up and neurorehabilitation counseling.

Pearls

- Sudden limb weakness or bladder or bowel dysfunction requires immediate clinical and radiological work-up
- Profound knowledge of nerve root patterns and a thorough clinical examination indicate the affected compressed nerve root or nerve roots
- PRMD and CES result in severe handicaps. Perform decompression surgery as early as possible to maximize recovery chances for your patient

Editorial Comment

It is the editors' strong belief, that a CES is always an immediate emergency situation and that there is no given time limit for surgery. A motor weakness grade 4 may be treated with prolonged conservative care, while a greater weakness should prompt urgent (<24h) surgery.

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Part II

Basic Module 2: Surgical Treatment of Degenerative Cervical, Thoracic and Lumbar Spinal Pathologies

Anterior Cervical Subaxial Treatment (Fusion)

3

Florian Ringel and Sven R. Kantelhardt

3.1 Introduction

Cervical radiculopathy caused by a soft disc herniation or a foraminal stenosis is a common problem. While symptoms from soft disc herniations have high chances to recover after conservative therapy persisting radicular pain or a neurological deficit are accepted as an indication for surgical treatment though high class evidence for the best timing of surgery is not available.

The surgical technique regarded as gold standard for cervical radiculopathy in the subaxial cervical spine is an anterior cervical discectomy followed by fusion as described in the 1950ies independently by Smith/Robinson [26], and Cloward [7]. With slight modifications from its initial description the technique is one of the most commonly used in spine surgery at present for cervical radiculopathy as well as myelopathy, and non-degenerative pathologies. While Smith/Robinson and Cloward described the use of autologous iliac crest bone for segmental fusion after a discectomy, nowadays most surgeons do use PEEK or titanium interbody cages leading to similar high fusion rates [3, 11, 18, 24, 25] but avoiding the donor site morbidity of an iliac crest harvest [18, 29]. Regarding the necessity of plating there is still an ongoing and unsolved debate and many international differences exist [33].

However, alternatives to ACDF for radiculopathy and foraminal stenosis exist for certain indications with posterior foraminotomy [10, 23] and total disc replacement [8].

This chapter will outline the indications for anterior cervical discectomy, the clinical and radiographic results as well as the potential complications and secondary problems. At the end of this chapter the reader should have an understanding of the benfits and limitations of anterior cervical discectomy and fusion in the subaxial cervical spine for degenerative indications as soft disc herniations and foraminal stenoses.

3.2 Case Description

A 46 y/o female patient with fluctuating right sided brachialgia for 1 year. She presented with acute exacerbation of her right sided arm pain (VAS 8/10), neck pain and dysesthesia of the right arm. No motor weakness on exam (Figs. 3.1 and 3.2).

After another course of conservative therapy during which the patient initially improved, her symptoms relapsed and after failure of further conservative therapy there was a relative indication for surgery. The patient underwent anterior cervical discectomy and cage implantation without plating (Fig. 3.3).

F. Ringel (✉) · S. R. Kantelhardt
Department of Neurosurgery, Universitätsmedizin Mainz, Johannes Gutenberg Universität Mainz, Mainz, Germany
e-mail: florian.ringel@unimedizin-mainz.de

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Fig. 3.1 The MRI scan of the cervical spine in the sagittal plane shows a large soft disc herniation at the level C5/6

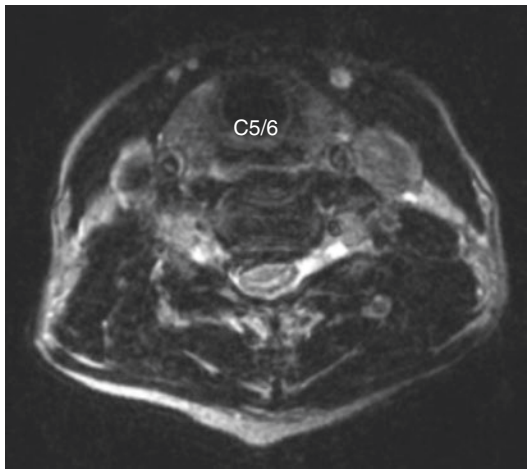

Fig. 3.2 The MRI scan of the cervical spine in axial cuts shows the broad based herniated disc reaching the foramen on the right side

3.3 Discussion of the Case

3.3.1 Indication

The patient described above suffered from radicular arm pain with sensory deficits but no motor deficit. She had a history of recurrent pain during conservative treatment with analgetics and physiotherapy for already 1 year.

Though the indication for surgery has not been proven unequivocally by large prospective randomized trials [16, 17], symptoms refractory to conservative therapy are accepted as an indication for surgery as well as motor deficits. So far, from few class II evidence and class III evidence the benefits of surgery in comparison to ongoing physiotherapy and analgetics have been shown [1, 5, 6, 19, 21, 22, 28].

The CASINO trial which randomizes ongoing conservative therapy versus surgery in patients with cervical radiculopathy is currently recruiting patients [32].

3.3.2 Choice of Surgical Technique

As surgical techniques an anterior cervical discectomy with fusion, a posterior cervical foraminotomy or an anterior cervical discectomy with total disc replacement are available to treat cervical soft disc herniations or foraminal stenoses.

However, the so called gold standard technique to treat a cervical soft disc herniation or a cervical foraminal stenosis is an anterior cervical discectomy and fusion. The surgical technique includes a standard anterior approach to the cervical spine, the disc is excised from anterior and completely removed, posteriorly to the posterior longitudinal ligament and laterally to the uncinate processes. After disc removal uncinate processes can be resected in order to decompress any bony foraminal stenosis. Finallly, the posterior longitudinal ligament is opened and resected to clear any disc material from the spinal canal and to visualize the exiting nerve roots. Following the decompression a fusion of the segment is usually performed originally by implantation of iliac crest bone but nowadays more commonly by implantation of a titanium or PEEK cage. Optionally an anterior plate is implanted to additionally stabilize the operated segment. However, the necessity of some of these surgical steps is questioned – as implantation of fusion material and plating – and will be discussed below.

In comparison to a posterior cervical foraminotomy and a total disc replacement an ACDF can be performed for almost any cervical anterior

Fig. 3.3 Ap and lateral postoperative x-rays of the cervical spine. Postoperative x-ray images of the cervical spine demonstrate an adequate cage position and regular alignment of the cervical spine

degenerative pathology irrespective of mobility of the segment or extent of degenerative changes of the motion segment.

Clinical results of anterior cervical discectomy are excellent for soft disc herniations as well as for foraminal stenoses and show an excellent outcome with a decrease of the mean VAS-score by 2.5–5.4 points for radicular symptoms and 2.0–6.0 for neck pain [1, 5, 22, 28].

Fusion rates were found to be 85%, 80% and 65% in one, two and three level ACDFs, respectively as reported in a meta-analysis [9]. Fusion rates can be increased by the addition of anterior cervical plates to 92%, 95%, and 83% for one to three level ACDFs. However, clinical results do not necessarily depend on fusion rate. While the implantation of iliac crest bone graft was the initial standard for ACDF [7, 25, 26], since many years cage implantation of PEEK or titanium cages is regarded as standard [3, 11, 24, 25] as the donor site morbidity of the iliac crest graft is omitted. Alternatively, even the anterior cervical discectomy without grafting for fusion is popular at some institutions [13, 27]. So far, while differences in fusion rates occur with iliac crest grafts resulting in the highest fusion rates, studies failed to show any difference in clinical outcome [13]. Therefore, it seems even less justified to perform additional instrumentation by anterior plates as a clinical standard for ACDF, especially as most early reoperations after ACDF are due to plate/instrumentation problems [12, 14, 31]. Only, for cases with a high amount of instability requiring immediate stabilization anterior plating is mandatory.

Typical approach related complications include intermittand dysphagia occuring in 2–83% and esophageal injury in 0.02–1.52% of cases [12, 20] and intermittend recurrent laryngeal nerve palsy with or without hoarsness in 2.3–8.3 and 15.9–24.2%, respectively, which led to lasting vocal cord palsy in 0.16–2.5% [4, 14, 30]. In other studies this rate could be significantly reduced from initially 6.5 to 1.3% by variations of the surgical technique, such as left-sided approaches and deflation of the endotracheal tube cuff [15, 30]. The only relevant long term complication of an anterior discectomy and fusion is adjacent level degeneration resulting from fusion and increased adjacent segment motion and the resulting biomechanical forces. A recent meta-analysis which analyzed radiographic adjacent segment degeneration and adjacent segment disease reported 47.33% (16–96) and 11.99% (1.8–36) following 106.5 months (24–296) after ACDF [2]. Clinical sequelae however are infrequent.

Alternative techniques to preserve segmental motion are available for certain constellations of soft disc herniations or foraminal stenoses as presented in the following chapters.

3.3.3 Accordance with the Literature Guidelines

As discussed above, insufficient data is available for the indication of surgery. However, the indication for surgery is in accordance with the general accepted criteria for a surgical treatment of a cervical disc herniation as well as foraminal stenosis. ACDF is still the gold standard for treatment of a herniated disc or foraminal stenosis though alternative techniques are available. The cage is the present standard to achieve fusion, the necessity of additional instrumentation with an anterior plate under ongoing discussion. Though different fusion rates exist following fusion with iliac crest versus cage and with and without plate, the clinical outcome is not different.

3.4 Conclusions and Take Home Message

Anterior cervical discectomy is the gold standard for cervical radiculopathy from a soft disc herniation or foraminal stenosis. Clinical outcome is excellent ragarding arm and neck pain. ACDF is suitable for most anterior segmental degenerative pathologies with all grades of segmental degeneration and segmental motion. Typical early complications of ACDF include anterior approach related complications as dysphagia and recurrent laryngeal nerve palsies, late complications are adjacent segment degenerations.

Pearls

- ACDF as gold-standard for cervical soft disc herniation or foraminal stenosis
- Titanium or PEEK cage are the present standard for fusion
- Anterior plating is not mandatory on many cases
- Clinical outcome does not correlate closely with radiographic fusion and/or alignment

Editorial Comment

It is our opinion, that it is not worthwhile to further discuss the question whether a plate is necessary in every case or not. It should remain at the discretion of the individual surgeon. A pragmatic approach is to add plates in cases of more that 2 levels, in segmental instabilities as seen on flexion/extension films and with risk factors such as smoking, osteoporosis etc. Further it is unnecessary to fill cervical cages with any kind of material.