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In daily radiologic practice the considerably increasing number of people suffering from low back pain - in western societies with a prevalence of 60 – 90% - is challenging diagnostic imaging disposing on various imaging modalities. The following techniques are available:

- **Contrast material / diagnostic tools**
- **standard images**
- **special projections**
- **functional projections**
- **layer images**
- **bone activity**

As well as modern digitised conventional equipment with a fully integrated PACS, we use a 16 row multislice helical CT-scanner (PHILIPS Multislice Brilliance CT) in our 200-bed-hospital; there are 6 (soon 7) MRI machines (up to 3 Tesla) available in the near surroundings.

The modern CT techniques, e.g. multislice scan technique with up to 64 row scanners, remain in many points competitive to MRI. Regarding accuracy, there is no difference, moreover, CT techniques are less expensive and the radiation dose is low by using dose modulating systems. We get optimal lumbar disc diagnostic results in using a combination of CT, CT-myelography and CT-discography.

Discography is indicated in patients who suffer from pain in the lower back, buttock and leg with negative or equivocal findings of nerve root or thecal sac compression by imaging techniques such as CT, MRI and myelography. In case of chronic lower back pain, with or without radicular symptoms, it is reported that up to 13% of abnormal discs as detected by MRI have a normal discogram appearance, while up to 7% of the normal discs as determined by MRI were abnormal in discography. Radial tears and often significant changes in the peripheral structure can be difficult to visualize reliably by a native MRI scan. Discography is also performed in an attempt to determine the presence of discogenic pain on a definite level, and so makes an integral part of different intradiscal therapy regime, e.g. chemonucleolysis.

CT myelography is used as a functional radiographic imaging technique and is indicated to clear up CT and MRI diagnostics together with complementary dynamic information. Myelography by itself is an excellent tool for dynamic and morphologic studies under almost natural conditions that can hardly be simulated under CT or MRI conditions alone - functional MRI scanners are available nowadays but are still rare. For spinal pain patients the still considerable exposure time in functional positions is often fostering movement artefacts with hence impaired image quality. Side effects of myelography are extremely rare and consists mainly in some headaches (about 1%), infectious or bleeding related problems could not be noticed in our large number of studies. Significant progress in CT hd/sw allow us to have a more and more accurate diagnosis and is related to progress in developing new multislice technique and image reconstructing process.

**Bibliography:** available from the author

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**Developments in the diagnosis of spinal disorders: the radiologists’ point of the view**

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**MR grading:** Reliable diagnosis of nerve root compromise is possible with a relatively simple grading system (no compromise, contact of disk material with nerve root, deviation of nerve root, and compression of nerve root). Substantial intra- and interobserver agreement (kappa = 0.72-0.77 and 0.62-0.67, respectively) was found in 500 nerve roots. Correlation of image-based grading with surgical grading was high (surgical confirmation available in 94 nerve roots, \( r = 0.86 \)).

**Lack of clinical meaning of certain MR findings:** At least one bulging disk was found in 62% and at least one disk protrusion in 67% of 60 asymptomatic volunteers (20 to 50 years old). Disk extrusion was not as common (18% of the subjects), and no disk sequestration was found. High intensity zones probably relating to anular...
tears were present in approximately 1/3 of the study population. In addition, endplate abnormalities were rarely found in the study population. 

**Positional MR imaging:** 30 patients with chronic low back pain were examined in a double-doughnut scanner. This method is facilitated by new MR systems with up to 32 acquisition channels allowing to obtain more data sets within the same period of time and to attach additional receiver coils without have to change plugs. Ten patients each with early and advanced ankylosing spondylitis were examined on a multichannel system. In both groups inflammatory lesions of the lower thoracic spine were common (7/9). In established ankylosing spondylitis the upper thoracic spine (3/6) and the lumbar spine (4/8) were more commonly involved. Abnormalities of the manubriosternal joint (2/4), the sternoclavicular joints (1/2) and hip joint effusions (4/3) were seen. Therefore, whole body MR examinations frequently demonstrate inflammatory lesions outside the sacroiliac joints. Distribution is similar in both groups but prevalence is higher in advanced ankylosing spondylitis.

**Whole body MR imaging:** This method is facilitated by new MR systems with up to 32 acquisition channels allowing to obtain more data sets within the same period of time and to attach additional receiver coils without have to change plugs. Ten patients each with early and advanced ankylosing spondylitis were examined in a double-doughnut scanner. This method has become more widely available on new MR scanners and can be used for quantitative assessment of fatty degeneration of paraspinal muscles. 25 patients with chronic low back pain (LBP) were compared to 25 age-, gender- and body mass index (BMI)-matched asymptomatic control subjects. The mean fat content of the multifidus muscle was significantly higher in patients with chronic LBP with 23.6% (95% confidence interval [CI] 17.5%, 29.7%) compared to 14.5% (95% CI: 10.8%, 18.3%) in the asymptomatic control group (p=.014). This difference was not recognized with a qualitative grading on standard spin-echo images.

**References**


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**Anatomical pathways and hints in lumbar transforaminar/interlaminär endos**

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Intradiscal and endoscopic therapy with the aim of decelerating, halting or even reversing degenerative disc changes may in a future become an alternative to fusion surgery and currently available motion-preserving surgical techniques. The biological acceleration of fusions would appear to be an alternative option. The problem with such biological options, however, is the deleterious impairment of segmental spinal mechanics that inevitably exert enormous forces on the stabilizing anatomical elements. Many manifestations of lumbar motion segment degeneration like internal disc disruption, disc dysfunction due to the delamination of the annulus fibrosus, and also slackening and incompetence of the outermost annulus, longitudinal ligaments, inter-and supraspinous ligaments and instability/subluxation of the facet joints, all can cause debilitating low back pain and radicular symptoms. In the early stages of DDD these stabilizing structures are anatomically intact, although relaxed and therefore not functioning properly due to altered mechanics and insertion sites.

In early stages of the degenerative cascade, the internal disruption of the disc and early endplate changes reflect the disturbance of fluid transport through the endplate, and also a disequilibrium between the intradiscal and the intravertebral=intraosseous pressure. In later stages the cross-linkages between the
annular collagen lamellae are progressively broken by a combination of malnutrition and mechanical attrition. Later stages of the disease encompass gross delamination of annular lamellae, sometimes with vacuole formation and the separation of the inflamed outermost annulus fibrosus from the remainder of the disc. We also conducted a cadaveric-experimental study pertaining to posterior percutaneous or endoscopic surgical approaches to the intervertebral discs. The study clearly showed that any uni or biportal approach to the lower lumbar spinal discs carries potential risk for injury or violating blood vessels or neural structures, in particular the delicate dorsal root ganglia. In all postsurgical specimens of patients who had had posterior lumbar surgery, extensive scar transformation of the erector spinæ muscles was consistently observed. Not only were the erector trunci muscles affected, but also the deep short oligosegmental muscles which account for the proprioception and fine-tuning of segmental mobility. In short as well as in long instrumentation, the scarring extended one or two levels above and below the intended instrumentation. All back muscles are contained in a non-expansile osseoaponeurotic compartment. When contracted, they constitute a powerful "dorsal soft tissue column" which stabilises the lumbar spine. Surgery must minimise violation of these muscles to avoid failed back surgery sequelae. In view of these findings, not only "muscle-sparing" but allout "tissue-sparing" approaches AND procedures are called for. While endoscopic approaches minimise this muscle trauma, both transforaminal and interlaminar approaches warrant topographic-anatomical consideration. The lecture will detail the anatomical structures along the pathway of both approaches, as well as potentially vulnerable structures to look out for, by the same token suggesting safe circumnavigation of neurovascular structures. The pre-eminent role of the dorsal root ganglion is demonstrated as well as the pathway of the root complex. Trans-and extraforaminal ligaments may impede endoscopic access. The two-layer construct of the posterior longitudinal ligament and the midline septum and epidural membrane are outlined. The peculiar insertion of the ligamentum flavum into the laminae below and above are decidedly different and important for creating optimum access and visibility of the lateral recess and central spinal canal. Another consideration if the location and size of the interlaminar retrothecal fat pad. Its vascularity is demonstrated and its mechanical significance in spinal stenosis is shown in specimens and clinical radiographs.◆

Anatomic study on lumbar pedicle / adjacent neural structures

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Study Design: The lumbar pedicle morphometry and its relationship to the adjacent neural structures from L2-S1 were investigated by anatomic dissection in 14 human male adult fresh cadavers.

Objectives: The goal was to better understand the relationship between the lumbar pedicle and the adjacent neural structures.

Summary of Background data: The lumbar spine stabilization based on vertebral pedicle has been increasing to stabilize the motion segment for the treatment of several diseases. Recently with the advent of percutaneous implantation of the pedicles screws there were increasing necessity to better understand the exact anatomy of the vertebral pedicle and his relationship with the adjacent neural structures. Based on the study accomplished by Ebraheim in 1997, we decided to do anatomical study in cadavers to better understand the anatomy of that area.

Methods: The size of the lumbar pedicles was assessed by measuring its longitudinal and transversal diameter. The relationship of the lumbar pedicle to the neural structures was evaluated by measuring the distance between dura-mater and the pedicle medial area, the distance between the most distal area of the pedicle and the nerve root that appears under it, and, the distance between pedicle apex and the nerve root that appears over it.

Results: The acquired results showed that the distance between the most distal area of the pedicle and the nerve root that appears under it, and the distance between the pedicle medial area and dura-mater, do not increase from L2 to L5, and they are in average 1.98 mm and 3.02 mm respectively. The distance between the pedicle apex and the nerve root that appears over it, increases from L2 to L5, varying from 13.64 mm to 21.62 mm in L5. The location of the spinal ganglion in relation to the pedicle has also been found, and 87% of the spinal ganglions are located in the foraminal zone.
Conclusion: The size of lumbar vertebral pedicle increases from L2 to L5 in both longitudinal and transversal diameter. The transversal diameter of the pedicle is smaller than the longitudinal. The lumbar vertebral pedicle has close relationship with the root that emerges below it and the most distal portion of the pedicle is adjacent to the root and its medial border is adjacent to the dura-mater.

CT guided therapeutic infiltrations

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Indications for CT guided therapeutic infiltration of the spine are cervical or lumbar radicular pain, sensory motor disturbance with maintained neurologic function and pain/paresthesia with insufficient response to other conservative measures. CT guided infiltration is used for diagnostic /therapeutic purposes in patients with equivocal unilateral upper or lower extremity pain, failed spine surgery and rarely multiple nerve root symptoms. 655 CT guided infiltrations were performed in the MRI Institute in the year 2006.

Imaging examinations provide an anatomic basis for a clinical diagnosis and therapeutic plan. CT guided therapeutic infiltrations are aimed at targeted treatment of spinal nerve root and dorsal root ganglion (DRG) compromise and at local medication of osteoarthritic inflammation of the facet and illo-sacral joints. Other indications comprise lateral atlanto-axial osteoarthritis, occasionally spondylolysis and nearthros associated pain at the lumbo-sacral junction.

CT guided therapeutic infiltration are directed to revert the inflammatory response at the root ganglion exerted by disc substance and chronic osteo-discal compression as delineated by CT or MR imaging. In the cervical spine infiltration is performed with local application of 1ml triamcinolone 10-40mg by a 0.50 mm (25G) needle. In the lumbar spine a 0.70 mm (22G) needle is used with 40 mg triamcinolone and 0.5 -1ml bupivacain 0.5%. Based on symptomatology and imaging, treatment in facet joint ostearthritis is aimed at pro-inflammatory mediators like prostaglandins, leukotriens and cytokines. A 25G needle is used to apply 0.5ml bupivacain and 10mg triamcinolone for each facet joint.

Cervical nerve root blocks are obtained by CT guided percutaneous infiltration aimed towards the spinal nerve root in the inferior interpedicular compartment and rarely to the epidural space. Nerve root compromise in about 50% of patients occurs within the foramen, followed by the foraminal entrance, while only 20% of radicular symptoms are caused by compression within the cervical spinal canal. Treatment results are best in foraminal and entrance point compression. Unsatisfactory response frequently is related to concomitant spinal canal stenosis. A meticulous CT guided technique and control of the position of the needle tip and injection of 0.5ml iopamidol 300mg/ml (Bracco) to assess the distribution of injected fluid assures treatment results and avoids complications like epidural hematoma, anterior spinal artery syndrome or vertebral artery injury.

CT guided control facilitates access to the L5 and S1 root for anatomic reasons and on all levels in patients with instrumentation assisted stabilization procedures. The CT guided lumbar nerve root infiltration with pre-treatment injection of 1ml contrast material assures precise positioning of the needle tip. Targeted selective application of medication is feasible in intraforaminal, interpedicular -epidural and intra- extraforaminal compartments. Treatment results (>60% reduction of symptoms) are positive in 80% on a short term basis, 30-60% show permanent improvement including repetitive injections in 10% of patients. In patients with combined osseous and discogenic nerve root compression, pain relief is frequently more pronounced than in patients who present with symptoms related to discogenic compression only. Lumbar radicular pain on the other hand responds better to periradicular treatment when induced by disc herniation related to the intervertebral foramen than to spinal canal stenosis. Implementing the concept of anti-inflammatory CT guided treatment for foraminal stenosis as well is supported by a pronounced pain reduction in the majority of patients.

CT guidance facilitates targeted therapy in patients with previous surgery compared to fluoroscopy guided treatment. CT imaging allows to adapt the infiltration to altered anatomy caused by scar tissue, recurrent disc herniation or progressive discogenic compression. Multilevel radicular symptoms and sciatica are indications...
for an epidural steroid injection. Based on our experience in concurrence with others epidural treatment is effective in sciatica. The controversy as to the influence on symptom relief is based on uncertainties about the indication and methodological aspects of the ideal administration of the steroid.

In facet joint syndromes the therapeutic effect is supplemented by a diagnostic component. A beneficial effect for lumbar facet joint treatment is expected to occur in 75% of patients on a short term basis, 3 months improvement is found in 33%. Intracapsular and periarticular treatment do not exert a different effect. Careful conduction of CT guided infiltrations and assessment of treatment results assures improved outcome and avoidance of complications in patients with spinal symptoms.

**CT-guided disc surgery**

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Purpose of the research: to define the efficiency and capabilities of CT- controlled endoscopic surgery of lumbar disc hernia. Material and method: method has been used since 1998. Endoscopic nucleotomy is being realized in 4 variants:

1. Percutaneous endoscopic lumbar nucleotomy (232 pts).
2. Percutaneous endoscopic transspinal hernioectomy (86 pts).
3. Percutaneous endoscopic lumbar nucleotomy via the axis of the ileac bone (14 pts).
4. Combination of endoscopic nucleotomy and laser decompression (112 pts).

Indications and contraindications have been described in detail in literature. The manipulation has been undertaken in an operation room equipped by CT using spinal navigation system. The operation included the following stages: CT discography, the working tube control, endoscopic nucleotomy, post-operation CT.

Results: long-termed effects were documented during 8 years after the operation. Excellent and good results were observed in 79 - 32 %, satisfactory results were observed in 10-12 %. Open operations have been performed to 10 – 15 % of patients.

Complications: vertebra fracture (2 cases), discitis (3 cases), allergic reactions to local anesthesia (3 cases).

Conclusion: CT-controlled endoscopic nucleotomy of lumbar discs is a safe and effective procedure under strict account of indications and contraindications.

**Neuronavigation CT-Scan guided in minimal invasive spinal surgery**

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The new concept of minimal invasive spinal surgery, nowadays appears strictly linked to the possibility of a surgical navigation guidance. Intraoperative CT-Scan multislices (Toshiba Aquillion 64 Slices) permits an accurate target respecting the coupling of a surgical approach faster and precise. In several fields of minimal invasive approach these techniques are applied (i.e.: percutaneously intradiscal treatments, vertebroplasty, kyphoplasty, bone spine tumors management and stereotaxis). In a comparative study on percutaneous Laser discectomy, a significant difference has been found under CT-Scan Multislices guidance in comparison to the standard C-arm guidance both in the success rate and in the possibility to treat successfully extruded disc. At the same time, the surgical treatment of vertebral fracture under CT-Scan permits to avoid the usual complications (bone cement leakage, pedicle fracture, fracture disruption). Regarding bone spine tumors management a correct and very precise imaging give the right surgical target in order to practise minimal invasive treatment (alcholization in metastasis, RF thermal ablation, catheter insertion). Finally a neuronavigation guided cecking permits also to study correct positioning on vertebral implants after percutaneous arthrodesis. In conclusion the future of "less is better, less is more" seems joined to the new perspective to perform robot or imaging guided aided surgery, to optimize the surgical approach and permite the more accurate treatment.
Peridural endoscopy: actual indication, experience and complications

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Indications: Epiduroscopy is an minimal invasive procedure for visualisation of the epidural space. Especially within the last decade it has become more and more popular especially as an interventional tool for treating patients with chronic back pain. Targeted epidural medication administered near the compromised spinal nerve is supposed to result in substantial and prolonged pain relief. On the other hand there are problems regarding a poor imaging quality as well as a small visual field. Epiduroscopy has been mentioned since 1931 (Burmann MS 1931) as an minimal invasive procedure for visualisation if the epidural space. Especially within the last decade it has become more and more popular especially as an interventional tool for treating patients with chronic back pain (Ruetten et al., 2002) Targeted epidural medication administered near the compromised spinal nerve results in substantial and prolonged pain relief. (Geurts et al., 2002). These authors have described the possibility to detect pathologies missed with the MRI. It has been found that epiduros copy is also an helpful tool in treating elderly patients with lumbar stenosis and radiating pain as it is possible to target adhesions and inject corticosteroids in combination with an local anesthetic at the site of pathology(Igarashi et al., 2004)

Experience: Since 2004 we have treated 27 patients. 19 had chronic back pain after lumbar disc operation, 7 presented with persisting problems after lumbar fusion and 1 patient presented with uncurable pain after Dynesis fusion. All of the 27 patients improved in their pain scale rating after operation. One patient following 4 previous disc operations needed PLIF fusion after the positive effect of the epiduroscopy lasted only for 4 weeks.

Complications: 1 patient described for one week problems with accommodation, another patient had increased pain for one week and one attempt to introduce the scope failed. We had no bleeding complications or head aches problems.

Conclusion: Epiduroscopy is a useful tool in patients with chronic back and leg pain with a low complication rate.

Is permanent neurodistruction necessary for lumbar facet joint rhizotomy ?
2-years results with percutaneous cryodenervation

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Background: Lumbar facet joint overloading is a central component of degenerative lumbar spine disease and in many cases is the predominant source of low back pain. The majority of trials have employed standard radiofrequency (RF) denervation for lumbar facet rhizotomy, a technique that generates a permanent colliquation necrosis of the medial branch. This leads to a permanent interruption of the facet joint sensory nerve supply as well as of the motor fibers supplying the multifidus and interspinalis muscles. In addition to the desired pain relief, this may also incur unwanted adverse effects such as the generation of Charcot joints and neurogenic atrophy of important paraspinal muscles. Interestingly, there exists no evidence in the literature to suggest that permanent neurodestruction is even required for adequate treatment success. In contrast to RF, cryodenervation has been shown to allow for nerve regeneration because it leaves important basal membrane structures intact. The few published trials on cryodenervation have shown results comparable to those of RF denervation. Work of other investigators has shown, that temperatures of – 20 degrees centigrade and below are sufficient to generate a prolonged nerve conduction block.

Study Objective: To determine whether percutaneous cryodenervation can adequately ameliorate low back pain originating from lumbar facet joints. Based on a 2 – years follow – up we thought to examine whether permanent neurodestruction is in fact required in order to achieve adequate pain relief. In separate laboratory experiments, we wanted to measure whether the cryoprobes used for the clinical trial generate temperatures compatible with prolonged conduction blocks and with nerve regeneration.

Material & Methods: Clinical Trial: Our target criteria were low back pain (VAS 0 – 10), limitation in daily activities and general acceptance of the treatment method. Inclusion criteria: Deep-seated non-sciatic low back pain, failure of conservative measures, positive diagnostic medial branch blocks. Exclusion criteria:
Continuous infusion of remifentanil under local anesthesia for minimally invasive spine surgery

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Introduction: Most of minimally invasive spine surgery has been performed under the local anesthesia with some analgesics and sedatives for awareness of nerve injury or pain relief immediately after the procedures. Remifentanil is the newest of the fentanyl family of short-acting phenylpiperidine derivatives to be released into clinical practice. It offers the same advantages such as profound analgesia, sedation, attenuation of the stress response. The unique pharmacology of remifentanil, in particular its rapid onset and offset, has more recently attracted clinicians especially procedures requiring a brief, intense, opioid effect. This study was performed to evaluate the efficacy and adverse effects of remifentanil under the local anesthesia during the percutaneous vertebroplasty and percutaneous endoscopic lumbar discectomy.

Materials and Methods: Continuous infusion of remifentanil in both fifty patients groups undergoing percutaneous vertebroplasty (VP group) and percutaneous endoscopic lumbar discectomy (PELD group) with a maximal anticipated duration of 60 minutes was performed. Continuous infusion rate for remifentanil was 0.1 microgram/kg/min. Visual analog scale (VAS) to evaluate pain during the operation, respiratory intervention scale, and postoperative nausea and vomiting (PONV) which were graded on a four point scale as 1 – no nausea; 2 = mild nausea; 3 = severe nausea; 4 = retching and/or vomiting) were checked.

Results: Mean VAS score was 3.4 and 3.2 in the group VP and PELD. There was no respiratory intervention during and after operations in both groups. There were 2 and 3 patients in the group VP and PELD who suffered mild nausea which did not need to treat.
**Conclusion:** Continuous infusion of remifentanil under local anesthesia may provide rapid and sufficient analgesia for ambulatory spinal surgery and could evaluate the result immediately after the procedures.

**References:**

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**Can society afford back ache?**

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The medical cost of treating backache steadily increases. Treatment gets more sophisticated and more expensive. Is the incidence of backache falling? No, it is steadily increasing. In the UK more people have backache each year and more people are off work for backache. Backache remains the most common reason for permanent disability, which can run into millions of euros per patient. How can we stop this? If no patient was ever treated would it cost more or less? The evidence is that larger operations lead to a small return to work but much larger compensation payout, usually against employers, but also against doctors.

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**Developments of perc. minimal techniques based on Japanese Hijikata’s school**

Percutaneous discectomy - its significance in minimally invasive spinal surgery

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At 1975 Dr. Sadahisa Hijikata presented a paper on percutaneous lumber discectomy in a Japanese paper, Journal of Toden Hospital. The title of the paper was, Percutaneous nucleotomy: A new treatment method for lumbar disc herniation. At that time almost nobody noticed the great role, that this method under local anesthesia will play. From the early time I myself know this method and sometimes observed how this surgery could be done in the Tokyo Denryoku Hospital. I surprised, this small surgery (at that time there was no word: Minimally Invasive Surgery) can solve symptoms of patients of lumbar disc hernia. But to regret, I and my colleagues, who saw this technique with me, could not notice the worth of this surgery. Doctors in the United States and European countries noticed the worth of this method first. This great sensation, such a small surgery can solve the symptoms of lumbar disc hernias, developed not only PLDD but also several minimally invasive spine surgeries. It can be justifies to say, the percutaneous lumbar discectomy opened the door of minimally invasive spine surgery at present.

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**Current status and challenges of MIS in Asia**

From Laparoscopic surgery to foraminoplasty using 2mm fine high-speed bur

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Japanese Society for the study of Endoscopic and Minimally Invasive Spine Surgery (JESMISS) has been found in 1998 and operated educational, scientific purposes or to do assist all those involved with health care and so on. In 1995 endoscopic surgery was introduced for the first time. At first laparoscopic spine surgery, retroperitoneoscopic spine surgery has been tried. At September 1998 MicroEndoscopic Discectomy (MED) was introduced in Japan and China. The number of posterior Endoscopic approach to the lumbar spine have gradually increased. So far about 19000 cases of posterior Endoscopic approach have already performed in Japan. On 13 May 2005 Japanese government has approved the application of endoscopic procedure to lumbar disc herniation.
The controversy in applying the use of PELD (Percutaneous Endoscopic Lumbar Discectomy) and MED to treat the lumbar disc herniation remains an issue of discussion in Asia. Foraminoplasty have been developed in Korea and Taiwan since 2001. We developed the technique of foraminoplasty in case of foraminal stenosis using the fine (2mm in diameter) high-speed bur 2 years ago. But the cause of intraoperative complications during this sophisticated surgery must be attributable to unrealistic and unpractical training system, shortage of experienced surgeons and no appropriate credentialing system. To overcome these problems, the Committee of Endoscopic Surgical Skill Qualification System has established the credentialing system to encourage the surgeons to be trained to obtain privilege of endoscopic surgery. They shall serve for a 3 years term. As to the number of cases necessary to certify that the applicant must have a competence to be able to complete popularized endoscopic surgeries by his or her own efforts, surgeons must have an experience with over 30 cases in posterior lumbar discectomy or 20 cases in endoscopic anterior approach experience of some advanced endoscopic surgeries in the field of spine surgery. With this approach, it is considered that liability as the certificate holder of Endoscopic Surgical Skill Qualification will let them contribute to further development of endoscopic surgery. Moreover we believe that the qualified surgeons are able to lead the endoscopic surgery to a correct direction through their daily activities in individual geographical location. ◆

History and evolution of arthroscopic & endoscopic lumbar disc surgery: the U.S. experience

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The concept of minimally invasive spine surgery (MISS) was formed in the 1970’s by those of us who had witnessed long term complications of extensive exposure of the surgical site and disregard of the integrity of the normal anatomical structures during spinal surgery. The contributions of Lyman Smith, Professor Hijicata, Professor Schreiber and Professor Leu in the field of MISS deserve recognition. My personal interest in MISS was ignited by reported satisfactory results via chemoneuculeolysis for the treatment of herniated lumbar discs as early as 1963. In the early seventies with permission of the Board of Governors of our institution we began to experiment with mechanical nuclear debulking via the available Craig cannula. By 1973 when I was working and teaching at The Graduate Hospital, University of Pennsylvania, there was a demand for objective demonstration of the effectiveness of central nuclear resection for the treatment of herniated lumbar disc. Therefore I combined the surgical exposure of the herniation site and the traversing nerve root with the evacuation of nuclear tissue via a Craig cannula that was inserted dorsolaterally.

This experimental work was followed by a number of anatomical and pathological studies that was subsequently published. The above investigations lead me to the conclusion that the removal of the symptom producing disc herniations via an intradiscal access required the use of a larger diameter cannula that could permit passage of upbitting and deflecting instruments to access and withdraw the herniated disc fragments from the spinal canal. Our first prototype instruments were produced in 1980 and lead to the first publication on this subject in western literature in 1981. Subsequently we published on periannular anatomy and identified the triangular working zone adjacent to the spinal canal as a safe zone for docking of the cannula and instruments. The description of radiographic landmarks of TWZ assisted surgeons to properly position the cannula while protected both the traversing and exiting nerve roots. In 1991 I had the privilege of publishing the first textbook on MISS in which we were able to demonstrate the arthroscopic and endoscopic appearance of various anatomical structures during surgery. The horizon of MISS gradually expanded to subligamentous and transforaminal access to the sequestered disc herniation. Decompression of lateral recess stenosis, nuclear replacement, anterior column stabilization, percutaneous insertion of pedicular screws, endoscopic laminotomy and foraminotomy and the treatment of a variety of spinal disorders followed.

The contributions of many investigators to the posterolateral access namely Jim Reynolds, Jonathan Schaffer, Anthony Yeung and John Chow are appreciated. The work of Richard Fessler, Richard Guyer and Hal Matthews in endoscopic laminotomy and discectomy should be recognized. The research and clinical studies of John Regan and Paul McAfee in the field of transthoracic and transperitoneal approaches to spinal disorders and so many others investigators in the field of minimally invasive surgery should also be applauded.
Percutaneous endoscopic lumbar disc surgery: the pioneering years 1979-1991

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As early as in the early seventies, in the United States KAMBIN applied a modified CRAIG's instrumentarium for minimum possible fenestration of the annulus fibrosus. In the same period, HIJIKATA introduced in Japan smaller instruments than the Craig's cannulas for now purely closed percutaneous removal of disc tissue by dorsolateral intervertebral puncture. The aim was the same as for KAMBIN: decrease of intradiscal pressure for indirect reduction of the posterior bulge in protrusions. His original publication of 1975 remains the classic keystone for the later considerable evolution of purely percutaneous disc surgery.

In Zürich, having learnt about the experiences of HIJIKATA in occasion of the SICOT Kyoto meeting in 1978, we adopted this operative technique in 1979, starting with Hijikata's original instruments. After a first series, this instruments, conceived for the rather small asiatic statures, could not completely satisfy the needs for the taller european statures. So we had to redesign and adapt the tools in 1980. The result was a pluricannular instrument for bilateral percutaneous approach (Howmedica™), which after several further modifications in design and material still is basically in use for the actual percutaneous techniques.

Experiments on cadaver specimens demonstrated in 1981, that the former experimental technique of arthroscopy (Storz™) could be adapted also for intradiscal control in combination to the bilateral percutaneous approach. So in 1982, with a modified arthroscopic device, together with my late cooperator SUEZAWA, we performed successfully for the first time "in vivo" this percutaneous discoscopy. This keystone for further evolution of endoscopic spinal surgery was presented at the Spine Symposium in Erlangen in March 1983 and published for the first time in the western world in the Textbook "Neuroorthopädie", edited by D. Hohmann with Springer Publisher. This helpful routine procedure has been recognized and adopted in its fundamental value later also by other authors.

Our experience with percutaneous interbody bone grafting goes back to 1986/7. In 1988 external fixation following the technique of MAGERL (Synthes™) was in use for elective probatory lumbar spine fixation. In cases with positive response, together with my collaborator LEU, we started to perform then additional percutaneous interbody fusion in 1988. In our concept, the external pedicular fixation device is most valuable for identification of proper indication for fusion and, when necessary to evaluate the clinical impact of eventually necessary segmental realignment, distraction and/or correction of lordosis. For the adequate elaboration of the endplates, in 1988 also a special excentrically abrasive milling cutter was developed by LEU and has since become a standard tool (Aesculap™) for this decisive step of the procedure. In 1993 KAMBIN, in order to avoid external fixation, introduced his technique of subcutaneous bolt connectors (Smith & Nephew™).

With the clinical introduction of laser application under discoscopy, worldwide for the first time in Zürich in January 1989 by LEU, again an important step towards further minimized and selective subligamentary discharge of disc herniations became available. After preliminary experiences with the Excimer-UV-Laser and the Neodymium:YAG since 1991 the Holmium:YAG has been found the optimal available for disc surgery under endoscopic control. This for decompression and also for adequate evacuation of disc tissue in percutaneous endoscopic interbody fusion. Nevertheless, the mid term results of laser disc decompression remained below their promising early results so that since 1997 in our concept laser is no more in routine use.

Resuming the european evolution since 1979, the minimal invasive approach to the intervertebral space has outgrown to a complete therapeutic concept of percutaneous endoscopic spine surgery. So a tendency in the whole field of surgical procedures towards minimization of invasivity, conserving efficiency by endoscopic control has finally made its way also in the field of spinal surgery.

References:


Percutaneous lumbar endoscopy: evolution /actual foraminoscopic concept

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After the first decade with clinical experience in percutaneous intradiscal applications for intradiscal decompression since 1979 and endoscopic biportal technique since 1982, the idea to combine simultaneous endoscopic control with direct extradiscal tissue elaboration across an uniportal approach araised in the later eighties. Experiments with modified urologic workings-scopes designed for cystoscopic applications demonstrated in 1990, that endoscopic applications are possible also in non-preformed anatomical spaces when some hyperpressive irrigation was used for local atraumatic tissue spacing. So we introduced endoscopic coaxial foraminoscopy clinically for the first time in February 1991 for the treatment of a foraminal sequestrated herniation. A first publication on the early series was published in 1996. Since then the technology with improved endoscopic tools and irrigation systems as well as high-frequency cogulation under irrigation became almost standardized for this specific range of indication. The posterolateral approach from 9-12 cm from the midline follows the same criteria as for intradiscal applications, but the working cannula is directed to the foraminal sequestrum, which is extracted under endoscopic control then with a special working scope. Our first clinical series of 178 standardized cases brought successful primary results in 147 cases, including an initial definite learning curve. 24 patients needed later on conventional open surgery w/wo fusion. Here the initial results trend to "black or white": or the sequester is removed or not. Relatively freshly sequestrated fragments without local scar-adhesions are easier to remove. Anatomical limits can accrue in L5/S1 when high iliac crests can impair flat approach to medioforaminally located sequestra. For preop evaluation a 3d-CT offering clear bony analysis of accessible trajectories is most helpful. Detailed knowledge of foraminal anatomy is anyway mandatory. Hospital stay could be reduced to 2 to 3 days, outpatient care is possible nowadays as well. Other Authors as Destandau in France with his minimally-open endoscopically controlled technique for the posterolateral approach, and Ruetten from Germany with his original interlaminar approach completed further to the today wide range of well indicated endoscopic lumbar disc decompression techniques.


SMART®: endoscopic assisted lumbar surgery for tt of degenerative disc disease

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Abstract: In response to the rapid development and demand of outpatient minimally invasive surgical technique, the new versatile SMART® Endoscopic Lumbar Spine System (Karl Storz GmbH & Co., Tuttlingen, Germany) was developed to provide the necessary bridge between traditional and endoscopic spine surgical techniques. Through a small skin incision, and dilatation surgical technology, this endoscopic assisted surgical system, with progressive sized serial tubular retractors or working channels, provides superior lighting and clear viewing of internal operative field, for performing minimally invasive spinal surgery (MISS). It incorporates the advantages of posterolateral endoscopic lumbar system, and paramedian endoscopic assisted microdecompressive surgical spinal system. Because of the unique features of the SMART® endoscopic tubular access set, the surgeon can take advantage of microscopic, endoscopic, or direct-vision imaging during spinal surgery for microdecompression.
of herniated lumbar disc, degenerative spinal disease, spinal stenosis, and removal of intraspinal lesions besides spinal arthroplasty and spinal fixation. This less traumatic easier outpatient SMART® Endoscopic MISS treatment appears to be easy, safe, and efficacious leads to excellent results, speedier recovery, and significant economic savings.

References:

Lumbar endoscopic disc surgery: the Osnabrucek’s experience

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Percutaneaus endoscopic lumbar discectomy (PELD) in the treatment of far lateral disc herniation was introduced in 1997 in our institution by our late colleague Dr.Schumacher. Since then nearly 200 procedures are carried out with this technique. My own experience bases on nearly 100 cases from 2000 to 2006. A retrospective analysis was performed of 81 patients who underwent surgery via dorsolateral endoscopic approach in general anaesthesia. Excellent or good outcome was obtained in 54(66%) of 81 patients. 15 patients (18.5%) experienced fair outcome, 12 patients (15.9%) had poor outcome and subsequently underwent open surgery. ◆

Interlaminar biportal endoscopic lumbar discectomy: 7 years of experience

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The purpose of this paper is to detail my experience since 1998, including ‘pearls and pitfalls’, with the technique of Inter-laminar endoscopic lumbar discectomy. This is a technique in which through two 5 mm portals in the midline of the back, the disc is approached through an inter-laminar approach under endoscopic vision. The scope is introduced through one portal and the working instruments through another portal. The study involves 400 patients operated since 1998 with a modified McNab score of 88% good-excellent results. The learning curve is steep in the beginning but with good grasp of endoscopic anatomy, the technique can
be mastered easily. Patients with fair and poor results are analysed in this study and the reasons have been established which will help a surgeon in his case selection. All the complications encountered are discussed and the pitfalls analysed. How to improve the endoscopic vision when there is a ‘red-out’ is also discussed. Endoscopic anatomy is explained. Strategies to master the technique are detailed. Lateral recess stenosis can also be treated endoscopically and this is also explained. Instruments required for the procedure are described along with the surgical technique. •

**Benefit of endoscopic disc and spinal surgery. 7 years of neurosurgical experience**

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Minimally invasive techniques in spine surgery have progressed rapidly, giving the surgeon endoscopic tools that improve his ability to treat spinal disorders. However microsurgery is still the gold standard in the treatment of lumbar disc herniations. But some disc problems are challenging and the use of a monoporal endoscopic system is beneficial: in a far lateral disc herniation the system is able to decrease duration of the procedure and reduce associated morbidity.

We present a series of 15 patients with a far lateral disc herniation in L5/S1. The clinical outcome in 10 patients was good or excellent. One patient was converted into an open procedure. 2 patients were reoperated later and 2 patients suffered from transient dysaesthesia. With the so called in to out maneuver a safe and clear visualisation of the exiting nerve root in the dorso-lateral approach is possible.

Due to anatomical conditions we can target medio-lateral disc herniations transforminal in upper lumbar segments without bone removal. Compared to open microsurgery we can avoid extensive bone removal and consecutive instability. In lumbar or thoracic disc infections the system is set up to deliver an antibiotic chain, to remove inflammatory debris, and to irrigate the infected level.

To improve stability on the spine with preservation of soft tissue we can additionally use a newly developed technique and system of percutaneous transpedicular screw and plate fixation with regard to lordotic or kyphotic curves.

In 10 of 12 cases of a spondylodiscitis we could heal the infection, some with and some without an additional instrumentation. 1 patient died and in one patient an open thoracic debridement with vertebral body replacement was necessary.

Needle biopsies of spinal tumors result in 20 % false negative. In 3 tumor cases we could harvest enough material performing a safe diagnosis.

2 isolated cases of a transthoracic monoportal endoscopic and a paravertebral lumbar endoscopic resection of the sympathetic trunk in pain management will be demonstrated.

**Summary:** From a neurosurgical point of view the endoscopic monoportal approach to far lateral disc herniations is probably the best indication for the disorder and in L5/S1 the first choice.

A dorso-lateral endoscopic access is helpful in the treatment of a intraspinal disc herniation of the upper lumbar spine and provides a good treatment option of lumbar and thoracic spondylodiscitis before an aggressive dorso-ventral resection and stabilisation should be performed.

First results in endoscopic tumor biopsie on the spine and monoportal endoscopic resection of the sympathetic chain seems to be very promising. •

**Cervical disc herniation treated with the transdiscal technique, a chance to prevent a cervical fusion**

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**Introduction:** The purpose of this study was, to evaluate results of minimally invasive surgical approach, using a new rigid fiber optic endoscopic technique in treatment of single level herniated cervical discs. The transdiscal endoscopic cervical disc operation is established since few years. Particularly the use of the 4 mm endoscope is a approved method in the daily work in our experience. There are no experiences in the use of a 6 mm scope. It is possible to remove adequate the central, the lateral, the intraforaminal and the transligamental herniated disc herniation at the cervical spine. Several levels can be operated in the same
session. The advantages of the method is the less traumatically procedure to protect the anatomical structures. Remarkable are the less numbers of instabilities. Further investigations have to show, if Operations in several levels increase one don’t increase the numbers of postoperative instability.

**Results:** The study was carried out as a short care surgical procedure between December 2002 and May 2006. Outcome based on questionnaires, phone calls and evaluation of clinical records. In a retrospective exploration of our endoscopic operated patients, we found 7% of postoperative instability. These patients got a fusion in the time after the procedure due to 6 month postoperatively. This experience is limited at the use of the 4 mm scope. How fare this statement can given in the use of the 6 mm scope needs more investigations.

From are 158 Patients in the ARKADE Clinic are endoscopic transdiscal operated at the cervical spine in one level. Patients with two or more levels are excluded from the investigation. In the postoperative control was done after 6 month. It shows that eleven patients developed a symptomatic postoperative instability and need a cervical fusion. Seven patients need a second operation because of incomplete removal of the freak disc herniation.

**Key words:** cervical vertebrae, minimally invasive spine surgery, cervical endoscopy, transdiscal approach, foraminal herniation, single level disc herniation, spine fusion surgery, cervical pain management, postoperative instability, headaches, radiculopathy, surgical safety, cervical discectomy, non fusion technology.

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**Endoscopic microsurgical treatment in cervical spinal stenosis**

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**INTRODUCTION:** Cervical myelopathy and cervical radiculopathy caused by degenerative disease has been surgically treated either by a posterior approach or by an anterior approach with or without interbody fusion. The posterior approach, that is to say the laminectomy, was first described in 1950 by Spurling and Scoville to treat primarily laterally displaced disc herniation. It has been used less frequently since the development of the anterior approach to the cervical spine. Positioning the patient in the prone position, the complications associated with posterior approach include nerve root injury, particularly when more than one root is exposed; spinal cord injury secondary to cord retraction, particularly during transdural approach to the herniated disc; spinal instability, particularly when the facet joint is removed; posterior muscle trauma and injury. For the past 40 years, the anterior approach has become very popular. Three common techniques of fusion are described by Cloward, Bailey and Badgley, and Smith and Robinson. In Cloward’s 1958 publication, he described his operative technique. With minimally invasive spinal surgery the trauma for the patient in the surgical area is minimised, and consequently iatrogenic effects may be avoided.

**MATERIALS AND METHODS:** This study was carried out from January 1991 to October 2006. Three hundred and eleven patients with symptoms of cervical radiculopathy and/or myelopathy should have undergone to traditional surgery. They were, instead, treated by using the endoscopic microsurgical techniques. In 287 cases the surgical procedure was performed by an anterior approach, while in 24 cases by a posterior approach. In the first time we used endoscopic microsurgery with posterior approach for the far lateral osteophyte in the stenosis of the foramen. The operative techniques must be followed carefully, in general anaesthesia, step by step, and the operating surgeon must be properly trained in these endoscopic techniques.

**RESULTS:** In our study there were neither incidents during surgery, nor major complications following these operations. We had in few cases transient hoarseness and dysphagia; in three cases transitory Horner’s syndrome, in some cases temporary paresthesias or hyperesthesias in a specific dermatome of the upper extremity, in very few cases fleeting neck pain, occipital pain or shoulder pain. During this study period six patients experienced relapse; three of these were operated again by the same technique and three in other hospitals. After surgery the success rate, according to Odom criteria, was 93.0% (289 patients).

**CONCLUSION:** This study suggests that for cervical spinal stenosis, the endoscopic microsurgical technique is an extremely advantageous and safe method. The goal of this surgical technique was to achieve direct and effective anatomical decompression of the spinal cord and nerve roots, without post-operative immobilisation by the maintenance of the integral spinal stability. By using this endoscopic technique it is possible to maintain a normal mobility of the intervertebral space, avoiding the inevitable stresses applied to adjacent interspaces following fusion and the consequent secondary morbidity. We think that a continuous development and improvement of instruments, a longer follow-up periods and a greater number of patient treated, will further confirm this endoscopic microsurgical technique.
Logical nexus in medicine and politics have a common sense: you hardly understand the present state when you do not know the evolution in the past. So historically investigating our actual understanding of today available sources, spinal surgery, in comparison to trauma-related or septic surgical procedures, due to its relatively short evolution, demanding nature in invasivity and complicative potential, is a relatively young discipline. It is only seventy years ago that a clear correlation between rupture of an intervertebral disc and possible involvement of the spinal canal with its nervous structures and its surgical therapy had first been established by MIXTER & BARR in 1934. So degenerative spinal surgery took its upraise from this moments. However, our knowledge of the vertebral disc on the one hand, and of myelo- and radiculopathies on the other, is older. Some of the main steps from greco-roman classics leading to the final "discovery" of the disc herniation are pointed out and illustrated. ◆

Full-endoscopic interlaminar lumbar disc surgery: technical development and clinical facts since 1999

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The therapy of degenerative diseases of the lumbar spine involves both medical and socioeconomic problems. A surgical procedure may be necessary if conservative measures have been exhausted and states of exacerbated pain or neurological deficits persist. Despite good therapeutic results with conventional operations, there may be consecutive damage due to traumatization. Thus, it is important to continuously improve these procedures. Taking existing quality standards into account, the objectives must be to minimize operation-induced traumatization and negative long-term sequelae. Current research results and technical innovations must be critically applied in order to guarantee the best-possible treatment strategies. Minimal-invasive techniques can reduce tissue damage and its consequences. Endoscopic operations under continuous fluid flow bring advantages which raise these procedures in many areas to the standard level. Lumbar transforaminal procedures with posterolateral access have been used for more than 20 years. The work area is predominately intradiscal and intra- and extraforaminal. With the new developed lateral transforaminal access the spinal canal can be reached more sufficient under direct and continuous visualization. But the bony perimeter of the foramen limits the mobility and resection of dislocated herniations and the pelvis may block access to the lower levels. Thus there exist limitations to the transforaminal procedure. To enable the operation of pathologies be limited with the transforaminal technique a full-endoscopic interlaminar access has been developed since 1999. Problems arose technically from small and not actively-flexible instruments coupled with a small intraendoscopic work canal. Insumountable difficulties could arise in the resection of hard tissue, the anatomic access, the mobility and the elevated recurrence rate. New optics with an intraendoscopic 4.2-mm work canal and corresponding instruments, as well as shavers and burrs were developed with the objective of permitting full-endoscopic operating under continuous visual control.

Considering the indication criteria, now the combination of posterolateral and lateral transforaminal and the interlaminar approaches with the new developed endoscopes and instruments provides sufficient full-endoscopic decompression under visual control of lumbar disc herniations located within the spinal canal or intra- and extraforaminal. The results are equal to that of conventional procedures, but with all the advantages of a truly minimally-invasive procedure. In addition due to the possibility of resect bone in a sufficient way with the new instruments and burrs the indication is broadened with respect to techniques for spinal canal decompression. Further indications can be facet cysts, fusions and infections of the disc. But the technical development has not yet been completed, and there remain clear indications and limitations. However, total avoidance of known problems in spinal surgery can hardly be imagined. In addition, open procedures will remain as indispensable in the future as they currently are. At the moment the full-endoscopic procedures are estimated as a sufficient supplementation and alternative inside the complete spectrum of spine surgery. ◆
Randomized comparison: cervical nonendoscopic laser versus endoscopic nucleotomy
a randomized comparisation

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As a bridge between open and percutaneous therapy, endoscopy of the cervical spine started to be used at the beginning of the 1990s beside the nonendoscopic percutaneous cervical decompression, following good experiences on the lumbar spine. The principle of microsurgery is combined with the minimally invasive principles by bringing the optical level to the forefront of pathology. Access morbidity has been significantly reduced by the percutaneous access technique. Furthermore, a large proportion of the intervertebral disc, in particular most of the fibrous ring, is preserved. The pathology is only removed selectively in the area of the nucleus pulposus and on the dorsal fibrous ring. This preserves the remaining biomechanical function of the degenerated intervertebral disc. By means of tried and tested minimally invasive methods under vision, such as the use of a laser to ablate and shrink tissue, the risk of complications has been further reduced, at the same time as enhancing efficiency. The advancement of the endoscopic technique with increased miniaturization of the scope and working options led to a restriction of use. So that on the other side a nonendoscopic procedure guided flouroscopicly can replace very small endoscopes. The major factors favouring the cervical nonendoscopic procedure by NdYag Laser are the pressure reduction achievable by vaporisation of the intervertebral disc and the shrinking as a technique for pressure relief in the spinal channel.

After 15 years of experience with the cervical PLDN we started with the percutaneous cervical endoscopic nucleotomy in 2004 as further opportunity for cervical discal herniations to avoid an open surgery. It seemed that both has been competing procedures by similar indications, whereas for the PECD also noncontained extrusions on the disc level have been treated too.

Our aim was to compare bothe methods in the outcome and the safety. From a group of 30 cases 14 Patients underwend PLDN and 16 PECD. Thereby we got by subjective McNab questionnaire 65% for the PLDN and 76% for the PECD for excellent and good results after 6 weeks. Objectively the pain improved by PLDN from VAS 8,4 to 3,2 by PLDN and from 8,6 to 2,4 by PECD. By both methods neurological deficits disappeared.

Conclusion:
The investigation shows that the minimal invasive procedures PLDN and PECD are working well and are able to avoid in nearly all cases an open surgery. Meanwhile the Laser procedure is simple, save and fast, the endoscopic approach allows a visual controlled decompression into the epidural space. In our cases were no complications and the complication rate reported until now is much more lower than by open surgery. For selected cases both procedures will be an estimable third way in addition to dorsal and ventral surgical acceses.

Outcome of percutaneous automated discectomy versus endoscopic discectomy (in-out technique)

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MRI techniques may help in early diagnosis of disc herniation as well as allowing distinguishing radicular pain from other disorders leading to back pain. Minimal invasive spine surgeons have been able to conduct percutaneous approaches in order improve patient’s functional capacity and to eliminate the severity of pain. However, dynamic-MRI is more useful diagnostic method for such purposes than the conventional static MRI which mostly offering insufficient data for decision of minimal invasive surgical options

As peroperative discography is mostly late to prepare the appropriate endoscopic equipment and to decide type of the procedure, the discographic imaging should have been carried out prior to all MISS procedures. Thus, the surgeon will perceive the available endoscopic devices those would be necessary during the operation.
Here we present the comparison of results of overall success rates of three MISS conducting surgeons’ groups two of whom merely performing percutaneous automated blind discectomy (PADD) and the last using all endoscopic techniques beside PADD. The comparison criteria included the recurrence and open procedure rates as well as patient satisfaction rates. We concluded that endoscopic discectomy group’s outcomes better than PADD group and has low recurrence rate. ◆

**Treatment of medial/mediolateral lumbar hernia by videoendoscopic endospine technique**

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Introduction: The less invasive method of videoendoscopic endospine technique as described by Destandau is a probate method for the treatment of medial and mediolateral lumbar herniated disc. We assessed the clinical outcome of patients treated with this method. Furthermore we also evaluated to what degree blood serum inflammatory levels, as a parameter for tissue damage, increased compared to conventional open nucleotomy.

Patients and Methods: 127 (avg. age 33y; 17-61y) patients with an isolated lumbar disc herniation with sequestration were clinically assessed pre- (<1 day) as well as postoperatively (3-4 days and 6 weeks) using the VAS as well as the Oswestry Disability Index. All had only one segment surgery and were treated according to the method described by Destandau. Pre- and postoperative neurologic deficit was evaluated. Intraoperative adverse effects and postoperative complications were monitored. Average hospital stay as well as patient satisfaction was determined. Furthermore we compared the biochemical serum levels of C-reactive protein and leukocyte count of these patients treated by this method to 179 patients operated on in an open technique (partly microscopic, partly conventional). All patients received a single shot preoperative dose of antibiotics.

Results: 94% patients showed an improvement of their pain symptoms after surgery. Preoperative neurologic deficit (n=73) had resolved in 62% of patients at the postoperative assessment. 3 patients needed revision surgery within 6 weeks after initial surgery due to persistent pain and still visible sequester in the post-Op MRI. There were 5 dural tears, all of which were managed by a patch and caused no further clinical symptoms. In 4 cases a superficial infection was observed, of which only 1 needed surgical management. Deep infection was not seen. Postoperative CRP levels were significantly lower for patients treated with the endoscopic technique, compared to the open technique. Leukocyte count was slightly raised for the latter group, but this discrepancy was not significant.

Discussion: Compared to the literature, the less invasive method of videoendoscopic endospine technique for the treatment of slipped disc in the lumbar spine delivers favourable results. Apart from good clinical results, complication rates are equally as good or better than conventional techniques of surgery. C-reactive protein levels suggest that iatrogenic trauma is lower than for other surgical methods and that this may be a reason for the more rapid convalescence of patients. A long term follow-up is necessary to determine the rate of postdiscectomy syndrome. ◆

**Endoscopic anterior foraminotomy in the treatment of soft or hard cervical disc herniations**

Preliminary results in 20 cases

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Study Design: Antero-lateral approach with discectomy is the first step of most surgical procedures used to treat cervical degenerative diseases. In order to avoid discectomy, endoscopic posterior foraminotomy has been used from 2002 to February 2006. Since this date endoscopic anterior foraminotomy is routinely performed for any kind of degenerative diseases: soft or hard disc prolapses and foraminal stenosis. This study is to report our experience with this approach.
Material and Methods: The device (Endospine, Karl Storz GmbH, Tuttlingen, Germany) is composed of three tubes: one for the endoscope, one for suction and the largest one for classical surgical instruments. From February to December 2006, twenty patients suffering from cervical radiculopathy have been treated by endoscopic anterior foraminotomy, using Jho’s technique. Mean age is 43, sex ratio F/M is 3/1. The level of compression was C4-C5 in 1 case, C5-C6 in 10 and C6-C7 in 9 cases. Radiculopathy was right in 11 cases and left in 9. In 2 cases severe stenosis without disc prolapse was the cause of the pain, in the others disc prolapse was the main cause of the pain.

Results: Radicular pain desappeared in all patients with transient numbness in 2. No Horner’s syndrome occured. One dural tear was treated succesfully by compression with Surgicel.

Conclusions: These excellent results combined with almost no complication and the ability to use this technique for any kind of degenerative disease have led us to use it routinely and to reserve posterior endoscopic approach to soft C7-T1 disc. Nevertheless these advantages must be confirmed by long term results.

Endoscopic rhizotomy on dorsal ramus/medial branch for chronic discogenic/axial back pain

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Introduction: For the past 20 years, radiofrequency lesioning of the facet joint has been the standard approach specifically for facet joint mediated axial back pain. Little is known about the role of the dorsal ramus, which gives rise to the medial branch. With better understanding of the pathogenesis of low back pain, a visualized endoscopic method was developed to target lesioning of the dorsal ramus responsible for innervation of low back anatomy and related soft tissues responsible for chronic back pain.

Method: A prospective non-randomized pilot feasibility study was initiated to assess the effect of endoscopic radiofrequency lesioning of the dorsal ramus and its medial branch on relieving chronic back pain. Patient’s who had evidence of degenerative disc disease, lumbar spondylosis, and facet arthrosis on MRI who had predominant axial back pain and probable etiologic irritation of the dorsal ramus were considered for treatment. Patients who had at least 50% improvement of their back pain with facet medial branch blocks were offered this endoscopic procedure. Modification of Richard Wolf’s YESS cannula and a specially designed Ellman radiofrequency bipolar electrode were the surgical instruments utilized. Twenty patients were enrolled in the study from July through December 7, 2006.

Results: 20/20 had positive benefit from the rhizotomy at least equal to but mostly better than the pain relief they obtained with their medial branch facet injection. There was 100% patient satisfaction. None have regressed and none were worse. Some patients claimed to have 100% relief of their pre-operative back pain. Pre- and post op Vas and Oswestry scores were tabulated obtained and will be reported with minimum 4 weeks follow-up.

Discussion: The literature on the patho-anatomy and physiology of chronic low back pain has focused mostly on discogenic pain, felt to be responsible for 39% of LBP by discography. Treatment of axial back pain has been virtually ignored by spine surgeons except when associated with severe deformity or instability. The basic science literature has identified the medial branch of dorsal ramus as the nerve supply to the facet joint. The lateral branch has been virtually ignored, even though it is known to be responsible for the innervation to the soft tissues lateral to the facet joint line. Zhou reported on dorsal ramus syndrome as a cause of involuntary muscle spasm originating most commonly from L1 and L2. At this level, anatomic dissections show the dorsal ramus sending branches two to three levels lower, with pain is referred to the low back up to two segments lower. Zhou reported excellent results for relieving back pain and muscle spasm with cryo lesioning of the dorsal ramus at these upper lumbar levels. This study combines the time tested medial branch rhizotomy with the addition of dorsal ramus lesioning for the treatment of non-discogenic low back pain.

Conclusion: Most clinical presentations of non-discogenic low back pain likely involve the dorsal ramus. For chronic low back pain, ablation of the dorsal at L1 and L2 may relieve back pain two to three segments below. Dorsal ramus and medial branch injections may identify a source of low back pain that is amenable to endoscopic targeted lesioning that appears to be more effective than the radiofrequency lesioning currently utilized for facet pain. Compression of the spinal dorsal ramus is one cause of low back pain that is readily treated by this new technique. Clinical studies should be done to differentiate dorsal ramus mediated pain from facet and SI joint pain.
Microendoscopic decompression procedure for cervical radiculopathy and myelopathy
A prospective comparative study between conventional expansive laminoplasty and microendoscopic laminotomy for cervical myelopathy

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Recently, surgical strategies for expansive laminoplasty in cases of cervical spondylotic myelopathy have been developed. For instance, when axial symptoms following expansive laminoplasty have been reported the frequency is said to be three times that of cervical anterior interbody fusion. The invasion of cervical posterior soft tissues including muscles and ligaments has been considered to play major roles in causing axial symptoms. To alleviate these problems, we are applying microendoscopic laminoplasty (MEL) as a minimally invasive strategy for cervical decompression surgery. We are expanding the application of this technique from lumbar spine to cervical spine. The microendoscopic method is developing as an effective technique for bilateral decompression surgery that uses a unilateral approach. First, hemilaminectomy is performed. Then laminotomy on the contralateral side should be conducted. Finally, lamiplasty can be completed to enlarge the spinal canal. The aims of this study were to clarify whether the MEL technique is a likely candidate to become a new surgical method for cervical myelopathy as well as to evaluate the clinical outcomes including axial symptoms for MEL surgery.

Materials and methods: Forty-four patients with cervical spondylotic myelopathy were selected. There were 25 males and 19 females, and the mean age was 63 years old. This is a prospective comparative study between conventional expansive laminoplasty and microendoscopic laminoplasty for cervical myelopathy. All patients received either conventional or microendoscopic laminoplasty. The mean follow-up period was 14 months. The following items were evaluated for each surgical method. They were graded under the neurological evaluation system of the Japanese Orthopedic Association scoring system (JOA score), recovery rates of JOA score, visual analog scale (VAS) for assessment of treatment of axial symptoms, Short Form 36, blood loss, the change of C reactive protein levels (CRP) and the mean hospital stay, postoperatively.

Results: The mean recovery rate was respectively 51% for the conventional group, and 53% for the microendoscopic group. There were no significant differences between the groups. The VAS for axial symptoms was 3.2 for the conventional group and 1.1 for microendoscopic group. The VAS scale in the microendoscopic group was significantly lower than that in conventional group. As for the SF-36, the scores for both role emotion and social functioning in the microendoscopic group were found to be significantly higher than those of the conventional group. The amount of blood loss in the microendoscopic group was a quarter of that of the conventional group. The mean period for hospital stay was 9.8 days for the microendoscopic group. This figure was half of that found for the conventional group. The change of CRP levels for the microendoscopic group were also significantly lower than that found for the conventional group.

Conclusion: The microendoscopic laminoplasty group had clinical outcomes that were equal to, or had surpassed those of conventional laminoplasty. The minimally invasive technique of microendoscopic laminoplasty clearly decreased the development of axial symptoms, largely due to producing less damage to cervical soft tissues. Furthermore, microendoscopic surgery allowed patients to return to their normal daily routine more quickly.

Transvertebral herniotomy and its expansive indication

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This study analyzed results of anterior transvertebral herniotomy for cervical disc hernia in order to assess the usefulness of this procedure and possibility of removal of thoracic disc hernia using same technique. The advantages of this method are the simplification of postoperative management and less risk of degeneration of the neighboring spinal segments, because the operated segments retain a variable degree of mobility.
Materials: Anterior transvertebral herniotomy was performed in 30 patients who had cervical disc herniation without spinal canal stenosis. The treated disks were C3/4 in 4 patients, C4/5 in 6 patients, C5/6 in 12 patients, C6/7 in 4 patients, C4/5 and C5/6 in 1 patient, and C5/6 and C6/7 in 3 patients.

Methods: With the patient in the supine position, the side of the neck opposite to the herniated disc was incised for standard exposure of the anterior surface of the spinal column. If the herniated disc deviated cranially or caudally, the vertebral body on the side of deviation was exposed. Likewise, if there was lateral deviation of the herniated disc, the skin incision was made on the contra lateral side to the herniated mass, and the anterior surface of the vertebral body was exposed. Drilling was started with an air turbine drill at the center of the anterior surface of the adjacent cranial or caudal vertebral body. Drilling proceeded posteriorly or posterolaterally toward the herniated mass, and was stopped when the drill bit penetrated the posterior bone cortex. An operating microscope was introduced, and after checking the drilled-out posterior bone cortex, herniotomy was done through the drill hole, which was about 7 mm in diameter. The previously injected blue dye provided a good delineation of the herniated disc, especially if the mass had been extruded into the space between the superficial and deep layers of the posterior longitudinal ligament.

Results: In most patients, a good result was obtained, but simultaneous or subsequent anterior intervertebral fusion was necessary in 4 patients. In 1 patient, the two adjacent vertebrae had fused spontaneously.

Discussion: In patients with cervical disc hernia, not only radiculopathy but also myelopathy can be treated by this operation. However, in most patients with myelopathy the spinal canal is narrow relative to the spinal cord, so radiculopathy patients accounted for about a half of our series. The best indication for this treatment judging from our postoperative results is a large hernia associated with either myelopathy or radiculopathy in a patient without spinal canal stenosis. The most important points are that this procedure should be limited to localized soft disc hernias, and that bulging of the annulus fibrosus should be excluded. Recently Demura et al reported herniotomy between T2/3 using this technique. Usually sternal splitting approach is necessary for this level, therefore, this kind of approach may be useful if surgeons would like to treat patients minimally invasively.

References:

Unilateral microdecompression in lumbar canal stenosis with degenerative olisthesis

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The purpose of this report is to present microscopic decompression through unilateral approach in patients with lumbar spinal canal stenosis and to show follow-up studies of consecutive 321 cases including 250 cases with lumbar instability in X-ray film.

Indications: The patient who had following conditions was selected.
1. Main clinical symptom is cauda equina intermittent claudication
2. Main pathology showed by neuroradiological studies is dural compression by hypertrophied yellow ligaments.
3. Symptoms related to an unstable spine is mild.
4. Over 3 months conservative therapy failed to improve the claudication.

Method: A 3-4 cm posterior midline incision is enough to perform microscopic decompression. The one side of paraspinal muscle was divided by finger after cutting fascia. The operation field was maintained by special retractor designed by the author. A lateral half of spinal process was removed to obtain clear visualization. A deformed and hypertrophied inferior facet was reamed to be paper-thin with surgical air tome. A hypertrophied yellow ligament that compressed dural sac was released at its laminar attachments in both rostral and caudal lamina edges. Detaching yellow ligament from the lamina at one stage enabled us a safe decompression to neural tissue. We retracted dural sac medially and to observe the disc. To observe opposite side of spinal canal, light axis of the microscope was changed. It was possible to remove yellow ligaments of opposite side by using microscope.

Patients: We performed unilateral approach microscopic decompression in 433 patients with lumbar spinal canal stenosis from October 1, 2002 to August 30, 2005. We directly followed 321 patients at least 6 months (22.9 months in average). There were 148 females and 173 males. The mean age was 66.7 by.of.(37-86).
Preoperative JOA score was 15.9/29 in average. Patient-base outcomes were evaluated with SF36. Preoperative X-ray showed some instabilities in 250 (78% patients, including forward slipping, backward slipping, scoliosis and rotational instability.

Results: Preoperative 15.9 points of JOA score was improved to 21.9 points postoperatively. Intermittent claudication improved in 87% of patients and low back pain improved in 77%. However, numbness in foot improved in 56%. Seven of 8 Lower scales in SF36 were significantly improved. There were no statistical differences between the results in patients having showed instabilities and no instabilities. The post operative slip angle and percent slip did statistically not change. The postoperative Cobb angle statistically improved. Re-operation was performed in 30 of 69 failed patients. Twenty-seven patients was recovered with additional microscopic decompression surgeries. The fusion technique was needed in 3 patients.

Conclusion: We should perform spinal surgery as minimally as possible especially in elderly patients. A unilateral microdecompression with one stage resection of yellow ligaments enabled us a safe decompression to dural tube. The preferable prognosis was obtained with this technique in patients even with X-ray lumbar instability.

Hydrodiscectomy: a novel surgical technique on lumbar herniated nucleus pulposus

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Objective: Microdiscectomy is the surgical treatment of lumbar herniated nucleus pulposus (hnp). Traditionally, the procedure is performed through a hemi-laminotomy with gentle medial retraction of the affected nerve root, incision of the annulus and manual removal of disc material. This procedure provides 85 to 95% good to excellent outcomes in patients with radicular symptoms caused by lumbar disc herniation in the immediate post-operative period. However, longer follow-up reveals recurrent symptoms of radicular pain in up to one third of the patients. This pain can result from recurrent disc herniation or from fibrosis of the nerve root as a result of intra-operative manipulation. Despite optimal patient selection and surgical technique, the recurrence rate of lumbar disc herniation after lumbar microdiscectomy has been reported as high as 26%. Higher rates of recurrence of herniation are reported with larger annulotomies (>6mm). We hypothesize that the recurrence rate of lumbar disc herniation after microdiscectomy is lower in patients who have a smaller annulotomy, leaving a smaller annular defect after surgery. Additionally, the recurrence of radicular symptoms secondary to neurofibrosis in the absence of recurrent herniation can be decreased in patients who have minimal manipulation of the nerve root during resection of the herniated disc. Hydrodiscectomy is a modification of the traditional microdiscectomy technique developed at the Naval Medical Center, Portsmouth. Decompression surgery is performed using a canulated system and a Microresector (Hydrocision; Billerica, MA, USA). The canula dilates the fibers of the annulus 4mm resulting in a decreased annular defect, and the Microresector removes disc material with minimal nerve manipulation. The purpose of this study is to describe the surgical technique and report a case series detailing the effectiveness in treating radicular symptoms secondary to lumbar hnp.

Methods: Hydrodiscectomy is a technique which utilizes a 4mm canula to enter the herniated nucleus pulposus and the Microresector to remove nuclear material. The technique is effective in treating posterior lateral lumbar herniated discs (contained and noncontained), recurrent herniated discs and far-lateral or extraforaminal herniated discs in the lumbar spine. The surgical approach to the disc space is the same as the traditional microdiscectomy (hemilaminotomy for posterior lateral herniations and paramedian for far-lateral herniations). Once the affected nerve root and herniated disc is exposed and identified, a Kirschner wire is placed directly into the herniation adjacent to the nerve root. Care is taken to minimize manipulation of the nerve root. A dilator is passed over the wire followed by the 4mm working canula to a depth of approximately 8-10mm. The wire and dilator are removed and the Microresector is placed down the canula. The Microresector pulverizes and removes the disc material through an evacuation tube using a high pressure fluid jet. Once complete, the canula and Microresector are removed. Adequate decompression of the nerve root is verified with direct inspection and palpation.

Results: Hydrodiscectomy has been successfully performed at Naval Medical Center, Portsmouth, in over 40 cases. These are the results of three representative cases. Case 1 is a 22yo male with an 8 month history of back pain radiating to left leg. MRI revealed left noncontained L5-S1 hnp with compression of S1 nerve root. He failed to improve with conservative management. Patient underwent Hydrodiscectomy via a midline incision and left hemilaminotomy. Postoperatively, patient had complete resolution of radicular symptoms. Case 2 is a 44yo male complaining of back pain radiating to right leg. MRI revealed right far-lateral L3-4 hnp
A new look to the natural history of back pain

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Aim: Based on the personally management of 13,356 patients with back pain, the author present the exact cause of common back pain. Therefore the dilemma of “Idiopathic Back Pain (Bianchini, K.J. et al, 2005, Kim D. Het, 2005, Fritz J. Metal 2006) must be left to the history”. If we know the exact cause of back pain, the right treatment could be utilized. The economic and scientific important of this research could not be over emphasized.

Introduction: The bureau of Labor and Statistic reported in 1998 estimated 1.9 million industrial back pains with approximately direct expenses 418 billion dollars and indirect cost about 837 billion dollars (Melhorn, J. Mark, Spine 3, 411-416, 2003). The exact cause and natural cause of back pain is not known in medical literature. The author has reviewed the literature and present a new look to the natural history of back pain. The economic and the scientific points of this clinical research could not be emphasized.

Method:

Firstly, How Low Back Pain Leads to Leg (sciatica) pain?

1. History. The most patients particularly so called the blue collar laborer after the injury report something snapped or popped or disrupted on my back. But medical literatures are silent to describe what anatomical structure initiates the back pain. This author believe inter spinal ligament is a thin, non stretchable fails in first instant and causes back pain. The denial of such claim is very common.

2. Clinically, there is tenderness, sometimes gap as the results of rupture of inter spinal ligament. If it is incomplete it will be relieved in time, but if it is complete, will cause spinal instability and later sciatic pain, secondary to herniated disc. If we inject 2 ml. local anesthesias between the tender spinal processes, the patients pain temporarily completely will relieve. This proves the theory subjectively.

3. Radiology. A flexion and extension x-rays will show an increased gap between the 2 spinal processes with injured ligament and objectively confirm the diagnoses. This is one of the most important point which leads to litigation with extra, stress and expenses. The patient originally complains of back pain/sprain and later develops leg pain (herniated disc). The insurance authorities accept the responsibility for the back pain but refuse to authorize treatment for the leg pain. This is one of the important point of litigation and consequences.

Secondly, How Low back pain produce neck Pain?

This important point is concerning the physio-pathology of cervical, thoracic and lumbar curvatures. This author had found these curvature acts as inter connected water tubs. We read in high school, if one tub fills up with water, it will affect the rest of the tubs. Similarly if we do not treat well the herniated disc of lumbar spine on time it will produce hyper-lordosis lumbar spine. It will affect thoracic spine produce hyper-kyphosis; in turn it will produce cervical hyper lordosis and eventually neck pain, and pain also on the upper extremity (ies) as result of herniated disc. These are the natural history of back pain by one injury. The reverse may happen; a simple whiplash neck injury due to affect on spinal curvature may lead to herniated disc in lumbar spine. The denial of such claim is very common.

Materials: This new look to the natural history of back pain, is based on personally taken the history; diagnosed and managed 13,356 patient since January 1985 to January 2005. Every patients back pain was really diagnosed and treated on these groups of patient. We treated over 92% of these patients (good or excellent) with conservative management. We did not find even one back pain caused as result of psychiatric disorder.
Oxygen-ozone percutaneous nucleolysis: an animal model study

EXPERIMENTAL STUDY IN LAMBS.

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Non-invasive treatments are one of the first choice in most of cases of lumbar disk herniation. When this attempt fails to be effective, a wide number of minimally invasive treatments are now available such as laser or endoscopic discectomy, IDET and others. These techniques offer good clinical results with a well tolerated and cost effective procedure. However, late studies report as much as 20% treatment failure rate with a failed back surgery syndrome in around 15% of them. A reduction in herniated disk volume is the aim of any of these treatments in order to reduce nerve root compression. Percutaneous injection techniques such us pharmacologic discolysis are other treatment options and have shown good results. Recently, oxygen ozone therapy has become a new option of treatment for the lumbar disk herniation. Literature shows good clinical results of ozone therapy in the treatment of different medical conditions but very few is written regarding the anatomopathological result of ozonotherapy.

In order to study the anatomic effect, on the intervertebral disk of ozonotherapy, an experimental study has been done. Histopathological changes after intradiscal injection of different substances (air, anaesthetic gas, contrast and ozone) in healthy lumbar disks of healthy lambs, sacrificed within the 3d and 6th week after injection, have been studied.

On the other hand, we are awaiting for the results of the second part of this study based on the analysis of the effect of ozonotherapy over the immunological response on injured intervertebral disk (rabbit model). ◆

Disc-FX-nonendoscopic radiofrequency disc ablation/decompression/nucleotomy

First Experiences

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Since the sixties, there has been a tendency to develop less invasive and aggressive methods in the treatment of discale diseases following the experience of Mixter that micro discectomy is not the final solution for this at all. Therefore, percutaneous procedures have been used for decades as an alternative to conventional surgical methods. Chemonucleolysis and percutaneous discectomy as well as laser decompression and discectomy are established methods besides the endoscopic techniques as minimal aggressive techniques. In recent years, the use of High Radiofrequency energy was added to this spectrum. Although with some similarity to the use of laser techniques, there is also great difference in the use of the device. Every technique from thermocoagulation for annuloplasty to the "coblation" must be considered as unique procedure. Disc-FX (Ellman Innovations, NY) is a new minimally invasive technology for the treatment of diseases of the lumbar spine with high radiofrequency based on the extensive use and positive experiences with use in endoscopic spine surgery.

The purpose of the presentation is to assess the feasibility and the potential of the Disc-FX with 4.0 MHz radiofrequency in intradiscal use. First we will discuss basic investigations for the efficiency and safety for this procedure. Then we will present our first clinical results demonstrating the surgical technique with the special assessable probe. For this first feasibility study patients with radicular pain syndromes and simple neurological deficits as well as contained disc extrusions or protrusions has been included. We did the procedures in two different centers by different surgeons and investigated the outcome standardized.

The first results encourage us to further studies and seem to be comparable to the other non-endoscopic procedures avoiding an open surgery. ◆
Results of treatment by cervical nucleoplasty in radicular and axial pain syndromes
2 year’s follow up in 380 cases

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Material & Methods: The disc nucleoplasty is a minimally invasive plasma discectomy. 380 patients, suffering from chronic axial neck and cervical radicular pain syndrome were treated by the percutaneous disc decompression procedure of Nucleoplasty. The nucleoplasty is a new percutaneous disc decompression system, based upon the experience with chymopapain, nucleotome, thermonucleolysis, lase and IDET. The nucleoplasty is a controlled therapy: low temperature and controlled ablation. In one system you have two modes of action: ablation via plasma molecular dissection and coagulation via resistive heating. Nucleoplasty is an voltage mediated process. The temperatures in both modes between 40-70 °C. The tissue is broken down into elementar molecules and low molecular weight gases, i.e. oxygen, nitrogen, hydrogen, carbon, dioxide, etc.. The gases exit disc through introducer needle. The cervical Nucleoplasty-electrode (“wand”) is characterised by an small profile, bipolar, micro-machined tip and an loop tip of shaft. Design goal: no scar, decrease morbidity, out-patient-procedure. Outcome independent quantity of disc remove (average 0.5g).

Patient selection: Treatment of radicular cervical/axial neck pain: Cases with arm and / or axial neck pain has been treated. Importend is MRI evidence of contained disc protrusion. Discography, if indicated, has been done. Disc hight of 50-70% minimum is essential. Exclusion criterias: severe degenerative disc, spinal fracture or tumor, severe spinal stenosis, degenerative instability.

Results of the two year follow up examination: 69% of the patients were complete pain free, continues working regular duty. Complete relief of radicular pain and parasthesias. 9% reported intermittend occasional neck pain, never in the intensity of the pre-op state. Temporarely occasional pseudoradicular parasthesia, low grade. 14% reported about increase of neck pain during havy lifting ( over 15 kg) and progressive radicular arm pain and intermittend parasthesias 8 month after surgery. Narcotics temporarely needet. Resurgery has been done in 8%. 0 case of paresis. Examination 1, 3 and 6, 12 and 24 month follow up: 74 % good to excellent results. VAS score decreased from 8-9 pre surgery to 1-2 post surgery in 2 weeks. No medication after 2 weeks post op. 75% of these patients were completely pain free post operatively. 25% were pain free after 2-3 weeks after surgery. 17% acceptable: VAS score decreased from 7-9 pre surgery to 4-5 post surgery in 4 weeks, down to VAS 1-2 after 8 weeks. Medication was needet 4-6 weeks after surgery. 8% poor: No significant decrease of pre-operative neck and / or cervical radicular pain. Open surgery (fusion or artificial disc surgery) was done in 8%.

Complications: no bleeding, no infection, no postoperative instability. Conclusion: Nucleoplasty is a quick and safe procedure of minimally invasive disc-decompression with excellent clinical results. There is no significant difference between male and female patients. Significant pain relief postoperatively during the first 4 weeks after the nucleoplasty-procedure. Persistant pain relief in the follow up. No severe complications are reported.

Minimal invasive surgery of vertebral thoraco-lumbar osteomyelitis

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Surgical treatment of hematogenic vertebral osteomyelitis presents a serious problem. In this paper we describe advantages of the minimal invasive method which we have developed and used since 1991. We have provided surgical treatment for 232 patients aged from 16 to 80, with lesions in vertebral bodies from C4 to S1.

The basic principles of the minimal invasive method consisted in using both small skin incisions (6 – 8 cm) and dividing the thoracic and abdominal wall muscles along their fibers. Surgery at a vertebral segment level did not involve cutting the segment vessels of the vertebral bodies. Paravertebral tissues coagulated only over the area of the destroyed disk. No displacement of paravertebral tissues in its generally accepted sense (skeletonization) was performed. Spinal cord decompression was produced at the expense of the central parts of the affected vertebrae bodies and due to removal of epidural abscesses.
Anterior lateral thoracic spondylodesis was performed with the help of 3 to 6 rib autografts; lumbar spondylodesis – with autografts made of a wing of ilium.

77 patients aged from 18 to 75 have been operated according to the above-mentioned principles, among them 50 males and 27 females, 48 patients aged below 50, 29 patients over 50. There were 27 patients with lesions of the thoracic spine, 7 patients with lesions of the thoracolumbar spine and 43 patients with lesions of the lumbar spine. In all cases anterior lateral transthoracic and extraperitoneal approaches were employed.

On average, the operation lasted less than two hours (from one hour fifteen minutes to two hours thirty minutes) The average blood loss was 285 ml (from 70 to 500 ml, in 65% it was less than 200ml). However, according to other authors, the blood loss averages 1 000 ml and more, with the operation lasting 3 – 5 hours in similar cases.

We allowed the patients to get up 5 to 10 days after the surgery. The bone block between the operated vertebrae bodies was revealed in 98.7% patients 4 to 6 months after the surgery. The method that we have developed has enabled us to significantly reduce the time of the operation and anesthesia, blood loss and the traumatic effects of the operation. ♦

Minimal invasive technique for posterior reduction/canal clearance in thoracolumbar fractures

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Poster internal fixation is considered the golden standard for unstable burst fractures. The effectiveness of canal clearance by ligamentotaxis has also been proven in the past. However, the reduction manoeuvre was thought to be restricted to open procedures due to the need of distraction and lordosation of the internal fixator. In this study, the effectiveness of a minimal invasive procedure using a conventional internal fixator (USS, Synthes) was investigated.

Method: After prone positioning the patient on the table, the Schanz-screws are inserted into the pedicles through 4 separate 2 cm incisions. The connectors are fitted onto the screws and pressed down to the spine. Then, the rods are inserted into the connectors tunnelling the erector spinae muscle. The reduction manoeuvre is realised by distraction and lordosation over the lever of an additional gripper. The first 5 patients operated by minimal invasive method were compared to the preceding 14 patients treated by open procedure.

Results: We measured operating time, blood loss, reduction of the spinal alignment and canal clearance as well. Results: Operating time was slightly higher (95 min) compared to open procedure (78 min). Intraoperative blood loss was less (200ml compared to 341 ml), and the postoperative drains delivered much less (152 vs. 461 ml) in the minimal invasive (MI)-group. In the MI group, canal compromise was 20% pre-OP and 2% post-OP, whereas it was 36% pre and 10% post in the open group. Correction of the bisegmental angle was 9.2° (MI) vs. 10.1° (open), and the vertebral body kyphosis angle was reduced from −14.8 to −9° by minimal invasive procedure and from −16.8 to −4.7° by open reduction.

Conclusion: The results concerning effectiveness of canal clearance and spinal alignment are similar in open and minimal invasive procedures. Using the minimal invasive technique, the blood loss can be significantly reduced, and operating time should not be remarkable higher considering the learning curve. ♦

Minimally invasive surgery in spinal trauma treatment

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The surgery of a complicated spinal trauma remains a huge problem and a widely acknowledged challenge in spite of all the technological advancements of recent decades. As a rule, a traumatic shock complicating a spinal trauma prevents the surgeon from immediate invasion and limits the surgery volume. Meanwhile, contemporary standards of treatment require an urgent decompression of the spinal cord and stabilization of
the damaged segment. Minimally invasive surgery using state-of-the-art endoscopy allows to minimize both surgical trauma and blood loss.

The goal of this research is to investigate the possibilities of minimally invasive surgery for the decompression of the spinal cord and stabilization of the spine in case of severe spine trauma.

**Methods and materials:** In the period between 01.01.1997 to 31.12.2005, 104 patients with severe spine traumas, were hospitalized in the neurosurgical department in the Urgent Care Hospital in Kaliningrad. 66 (46 males, 20 females) patients (63.4 % of the total number) were in a state of shock. The average age of the patients was 33.4 years. The indications for urgent surgery were symptoms of dural sac compression or unstable spinal fractures. All the above said patients underwent surgery shortly after trauma. Patients with severe traumas were operated on shortly after admission, with the use of minimally invasive approach allowing to minimize intraoperational trauma. Optics and endoscopy were used for adequate decompression of dural sac and spinal roots. The operations carried out were as follows: 6 patients were operated on posterial decompression and posterial spondylodesis; 17 - on posterial decompression and transpedicular fixations; 8 patients underwent transpedicular fixations and anterior spondylodesis; 35 - anterior decompression and spondylodesis.

**Results:** 85% of the operated patients with severe traumas showed positive dynamics and regression of neurological deficit. The use of minimally invasive approach allowed to reduce blood loss by 50 % in comparison with traditional methods: meanwhile, the time of the operation increased insignificantly. The use of endoscopy in the decompression of the spinal cord allowed to better control the quality of the decompression during surgery.

**Conclusion:** Minimally invasive surgery in case of shock spinal trauma allows to drastically reduce the surgical trauma and carry out the decompression of the dural sac more efficiently. ◆

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**Minimal invasive experience with the semi-robotic MAZOR system for pedicle screw setting**

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Between November 14th, 2005, and September 5th, 2006 a first series of patients in Europe has undergone transpedicular instrumentation with 3D robotic assistance in the lumbar spine at our Orthopaedic Department. The prerequisites, methods, and results of this completely new technology which must not be confused with standard spine navigation will be presented in detail.

16 patients were randomly selected from our standard clientele for lumbar spinal fusion or dynamic stabilization via transpedicular instrumentation. Indication was osteochondrosis of the lumbar spine with or without spinal stenosis. 4 were female, 12 male, their average age was 55 years (22-74). They gave informed consent to the procedures and obtained thin slice CT scans of the operating field prior to surgery.

The MAZOR computer system then imported the CT scans and a 3-D planning of the pedicle screw placement was carried out by the same surgeon as the following procedures (M.P.): In case of additional decompression surgery this was carried out prior to pedicle screw placement. A fixation clamp in midline incisions or an iliac crest based bar for posterolateral incisions was fixed on the patient and the system was calibrated in the OR in connection with a standard 9” C-arm fluoroscope. On the clamp or the bar respectively a robotic device with a moving working arm was mounted. Automatic matching algorithms then made the robot point its arm towards the designated entry points of the pedicle screws. The latter could then be placed through the working arm, either cannulated (ICON) via K-wires, or solid (XIA) via standard awls, passing through a designated sleeve of the working arm. Percutaneous MIS insertion was also found feasible. Only standard ICON and XIA instruments were used. Instrumentation and bone grafting was then set forth after removal of the robot as usual. The CT accuracy of screw placement in all robot-assisted patients was scored according to Mattes et al. postoperatively.

One patient had to be instrumented manually for reasons unrelated to the system. In two early obese patients the system locked out due to insufficient non-pulsed fluoro matching, enforcing standard manual technique. In the remaining patients a total of 58 screws had to be placed. No clinical complication related to the MAZOR system occurred. A total of 6 screws could not be placed by the system due to spatial limitations in steep lumbosacral angles which have been overcome in the meantime by dedicated wedges. There was a steep learning curve in the procedure. In the beginning the average additional time of surgery was about 80 minutes which could meanwhile be reduced to 40 minutes per case.
None of the robotic screws was misplaced in the final CT. One of the four non-robotic screws was misplaced at the S1 level and needed replacement due to apparent nerve contact without paresis. The robotic screws reached an average Mattes score of 1.5 which can be considered superior to sole fluoroscopic techniques (2.5). Additional decompression did not impede the system which does not rely on surface matching. During the evolution of the system additional features became available: A designated stabilizer for the working arm, fixed to the bedrail, wedges for hyperlordosis, oversized sleeves for obese patients, oblique fluoro view acquisition for small image intensifiers, and a virtual trip throughout the entire vertebrae with a more realistic screw modelling.

The intelligent planning features of the MAZOR now also allows to avoid “supercharging” of the pedicle due to screw oversize, a feature which is lacking in conventional navigation systems. In some reviews such supercharging even breaching the pedicle wall in navigated techniques has not been considered a malplacement. Yet it can be clinically relevant. In one case we had to use thoracic 4.5 mm screws in the upper lumbar spine after running the planning software to avoid that risk.

This is the first report submitted worldwide about the beginning of robotic assisted pedicle screw placement in Europe on a non-experimental basis. The series has stimulated rapid improvement of the MAZOR System which now has proven its usefulness and potential for usage in daily routine at several spine centres. A modern 12” C-arm with pulsed mode will further add to the speed of the system and will be applied at our department in the future. The Mazor is both, planning and navigation tool plus mechanical insertion aid for the considerate spine surgeon who is constantly aware of his limits.

**Transforaminal endoscopic treatment of low lumbar scoliosis**

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Low lumbar scoliosis shows alternative collapsed discs and sciatica secondary to foraminal stenosis or alternative bulging. This stenosis causes leg irradiated pain in one or in both sides. Endoscopic surgery done by transforaminal approach helps against foraminal stenosis doing a laser and reamer foraminoplasty.

Unfortunately this is not enough for the associated low back pain, probably due to the collapse of the posterior articular process.

Unilateral expansion of the collapsed disc, by means a B-Twin expandable implant, can help to heal the chronic low back pain and sciatica in a simple way. Through the posterolateral approach, the implant can be pushed and expanded under endoscopic control.

No other incisions are necessary and it doesn’t require general anesthesia, as a light sedation is sufficient. The author shows some cases as an example of this complex technique.

**Interbody fusion with percutaneous cages**

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We have reported our technique of percutaneous placement of pedicular screws (PS) and plates at the previous meeting of Zürich. The way of thinking that has driven us to the conception of this device has led us to a new procedure for ELIF, avoiding the side effects of classic open surgery. The purpose of this study was to describe this new surgical technique and report the preliminary results of the procedure.

**Clinical material and methods:** 15 patients with degenerative spondylolisthesis or discogenic low-back pain underwent percutaneous ELIF in both our institutions on a period of 18 months. 12 were men and three were women whose mean age was 62. All patients had severe low-back pain or true radicular pain without compressive lesion inside the spinal canal at CT or MRI evaluation. No of them exhibited motor deficit in the territory of the concerned nerve, even though sensory disturbance could be seen in the same dermatome.
Surgical technique: the patient is placed prone on a standard frame dedicated to spinal surgery. All the procedure is driven under neuroleptanalgesia, the patient being conscious through all the time of the intervention. Local anaesthesia, using adenalized lidocain 2% is added through the expected muscular pathway, additional local anaesthesia without adrenalin 0.5% being used, if mandatory, intra operatively in close contact to the extraforaminal zone. Radioscopic equipment -a standard mobile “C” arm, allowing two plans permanent control- is used in all the cases. After tracing skin landmarks, a 18G, 15cm long needle is placed in the inter-vertebral disc, used as a guide for a K-wire, but as close as possible from the inferior end-plate of the inferior vertebral body of the level to be instrumented. The Europa* system (Neuro-France Implants, Boursay, France) is then used for the entire procedure. A set of sequential dilators increasing progressively in internal diameters until to 13.2mm, depending of the height of the inter-vertebral space, is used, owning the choose of a cage with specific design, coming in size from 4x6mm to 10x12mm, the length being always the same: 25mm. At that time, an endoscope could be set in place to look at the exiting and traversing nerve root, avoiding direct lesion by dilator contact. A discetomy made by special forceps passed through the last dilator is followed by a meticulous endplate cleaning up with curettes. Then, the cage, packed with bone substitute, is set in place. The final positioning of the cage is allowed by making a quarter rotation of it, offering by its special design. 2 mm more distraction of the disc space. Same procedure is repeated on the opposite side. Percutaneous placement of plates and PS can be then done in addition, using the WSH* system (Neuro-France Implants, Boursay, France) as first described. Patients are allowed to stand up the day following surgery, without need for bracing, the exit being authorized on the third or fourth day.

Results: all the patients experienced immediate pain relief, most of them being able to point it intra-operatively. Post operative X-rays and CT-control show good positioning of the cages and wide opening of the foramens. At the last follow-up examination (at least 3 months- to 15- after) the improvement of the clinical symptoms was maintained in all the patients excepted for, one being impaired by radicular pain coming from partial extra pedicular positioning of a screw, the second one showing unilateral pseudarthrosis on X-rays coming from a cage too small in size, the third and the fourth having an instable cage too lateral on the abnormally convex lateral end plate. The both first problems were resolved by new placement with the same technique, the both last complications needed an open PLIF. Mean VAS scoring of the first 13 patients was 7,2 before surgery and 1,7 after, operating time was 117mn, and blood loss was always under 50ml.

Discussion: To the best of our knowledge, it is the first time that such a percutaneous ELIF technique is shown. Its more important interest lays in minimizing surgical aggression, especially in old impaired patients, in whom risks of general anaesthesia and excessive bleeding can exclude them from this kind of surgery, even if it could be in theory a good indication.

Conclusion: We have purposed a new technique for ELIF surgery, using percutaneous setting of cages with or without the addition of percutaneous plates, without the need for facetectomy.

Two years follow-up after percutaneous lumbar fusion
A prospective study

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The aim of the prospective study was to examine advantages and disadvantages of less invasive spine fusion. In the literature there exists no prospective study with VIPER for less invasive fusion in the lumbar spine.

From Februar 2005 to November 2006, 72 patients were treated with the new instrumentation. All patients were instrumented percutaneous with VIPER. In all patients a monosegmental or bisegmental fusions in the lumbar spine were performed. Indication for surgery was in 35 cases osteochondrosis, in 10 cases spondylolisthesis, in 4 cases instability after arthroplasty and in 23 cases failed back surgery syndrom. In 35 cases anterior fusion with autogenic or allogenic bone graft was also performed. The mean age at operation was 48 years (range from 35 to 63). All patients were operated by one surgeon. For the clinical examination VAS, SF 36 and patients satisfaction score were used.

The mean follow up was 13 months (range from 3 months to 19 months). The mean time of operation was 65 minutes (55 to 125); blood loss was in mean 75 ml (10 to 150), skin incision 4.5 cm (4 to 8 cm). Fusion level were in 36 cases L5/S1, in 18 cases L4/5, in 7 cases L3/4, in 4 cases L4-S1, in 4 cases L3-L5, and in 3 cases L2 –L4. There was none infection, none neurological complication. In two cases we found a misplaced of pedicle screw medial outside of the pedicle. In one case a revision surgery was necessary, in cause of radicular pain.
The first results have shown that percutaneous pedicle screw instrumentation with VIPER is a reliable and simple technique. However, more prospective comparison study of an open and minimal percutaneous procedure with long time follow up are necessary.

**Indications & experience with perc.endoscopic cervical discectomy (PECD) w/wo B-twin stabilization**

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*Introduction:* Percutaneous endoscopic cervical discectomy (PECD) could be considered as a good alternative to the standard anterior cervical discectomy and fusion (ACDF) in dealing with soft cervical disc herniation. However, this procedure cannot be applied for patients with cervical disc herniation accompanied by segmental instability. Recently developed WSH cervical B-Twin can be used as an interbody spacer to achieve stability without open discectomy. The purpose of the study is to evaluate the efficacy of PECD and percutaneous cervical stabilization (PCS) with or without dynamic cervical stabilization.

*Materials and Methods:* The cervical working channel endoscope (WSH endoscopy set, Karl-Storz, Germany) for PECD has a working cannula that has integrated high-resolution endoscope, illumination, and irrigation. Therefore it allows surgeons to selectively remove the herniated disc via a Holmium: Yttrium-Garnet-Aluminum (Ho: YAG) laser and microforceps under endoscopic visualization. The PCS procedure also follows that of PECD. Under the fluoroscopic guidance, the reduced 3.3 mm cylindrical implant is inserted into the intervertebral disc space. Once expanded, its octagonal shape and fins prevent implant migration. Therefore, it restricts the excessive movement between endplates and to re-establish balance of cervical curvature.

*Results:* From January 2001 to October 2006, a total of 105 patients (M:F=62:43) were included in this study. Mean age was 44.13 years (range; 24-67 years) and mean follow-up period was 36.4 months (range; 2-70 months). The clinical outcome was evaluated according to the Macnab criteria. The surgical outcomes were excellent in 39 patients (37.1%), good in 49 patients (46.6%), fair in 4 patients (3.8%) and poor in 13 patients (12.3%), thereby indicating an 83.7% rate of favorable outcome. A total of 45 patients underwent PCS with cervical B-Twin at our hospital. Among these, 33 patients who were available for follow up were retrospectively reviewed for their clinical outcome. There were 18 male and 15 female patients with mean age of 46.9 years (range; 28-78 years). The preoperative mean VAS of neck pain and back pain were improved from 6.09 to 4.72 and 3.19 to 1.7, respectively. Mean ODI was improved from 47.82% to 14.46%. Based on the Macnab criteria, the surgical outcomes were excellent in 10 patients (30.3%), good in 18 patients (54.5%), fair in 2 patients (6.1%) and poor in 3 patients (9.1%), indicating a favorable outcome of 84.8%. There were two additional surgeries at the affected level or adjacent levels. The rate of return to work after surgery was 93.9%.

*Conclusion:* The procedure of direct fragmentectomy and manual decompression by microforceps and thermal effect of Ho: YAG laser under direct endoscopic view is safe and effective for the treatment of soft cervical disc herniations. In our experience, there is a very low associated morbidity with a rapid recovery resulting in a significant saving on expenditure. Biomechanically and clinically, PCS has potential to treat the angular instability. This technique prevents postoperative kyphosis and maintains anterior structures and stability unlike the conventional open procedures. In order to firmly establish the efficacy of B-Twin for treating segmental instability, further study requires large-scale trial long term follow-up.

**Experience with “Golden proportion” system in lumbar transpedicular instrumentation**

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Presently, the base and development of systems approach to the choice of optimum parameters of implants is an important and actual task. Deciding this task, we paid our attention to «Golden proportion» (GP) System and row of Fibonacci numbers.

It is known that correlations between many parameters of structural elements of human body are characterized by number, near to (GP) - 1,618, that testifies to the observed non Euclid symmetry. That fact was studied by the prominent researchers of many generations (Pythagoras, Euclid, Fibonacci, Luke Pachyli, Leonardo Da Vinchi and others). The using of «GP» in architecture allowed to create some world masterpieces, such as the Egyptian pyramids, Parfenon, Cathedral of Vasily Blazhennogo and others.

Number \( \varphi \) characterizing GP can be got different ways. For example, as limit of relation of members of recurrent row \( \{F_0 = f, F_1 = g, F_{n+2} = F_n + F_{n+1}\} \) so: \( \varphi = \lim_{n \to \infty} \frac{F_{n+1}}{F_n} = \left(\sqrt{5} + 1\right)/2 = 1.61803398... \) (in case when \( f = 0, g = 1 \) we will get the row of FBonacciachy). From other point of view, \( \varphi \) historically examined as a result of division of \( c \) segment on two unequal parts \( a \) and \( b \), so that takes place correlation \( \varphi = \frac{c}{a} = \frac{a}{b} = 1.618 \).

Observation of proportions of implanting construction and its parameters are one of the main tasks in the decision of questions of restabilization of spine.

The method of choice of screw diameter by GP system is the averages of horizontal diameter of arc root in a lumbar part of spine which make 9 - 14 mm, is the size \( a \). The range of diameters of transpedicular screws makes 4,5 to 8,5 mm, is size \( b \). Relation of \( a:b \) must be equal to 1,6. Then diameter of implant and diameter of arc root will be in GP. For example: for the arc root with a diameter 9 mm, in this proportion there will be a screw with a diameter 5,5 mm.

The Method of choice of screw length and it’s implantation by system of GP - transpedicular screw should be located in axis beginning from base of superior joint process of pr. accessorius to the ventral surface of vertebral body, that axis segment is the direction of insertion of screw - size \( a \), length of screw is size \( b \), they similarly must be in proportion of \( a:b=1,6 \).

One of analogues of GP is - called «golden triangle» is isosceles triangle with an angle in top 36˚. In this it’s foundation relates to lateral side «golden proportion» in regard to GP and characterizes an equilibrium and stability of the system.

Insertion of screws on the lateral sides of «golden triangle» consists in the following: point of insertion - pr. accessorius; angle of slope (convergention) - 18˚. Thereby an angle between two symmetrically inserted screws is 36˚,and transversal connector makes foundation of the well-created «golden triangle» which is built from the elements of the transpedicular system.

To our opinion, this approach to the choice of parameters of constructions and its implantation is the optimum system and requires the further study. In our clinic more than 70 transpedicular systems were implanted with that technology of GP with positive results.

More detailed information about history and modern use of «Golden proportion» is on site: www.goldenmuseim.com ♦
where ceramic grafts were used.

Results. During experiments it was proved that in early postimplantation period HA and TCP did not disturb cell hemataxis into defect area (vertebra, femur head, femur distal metaphysis). Ceramics integration occurs due to the formation of connection zone where processes of cell proliferation and differentiation and bone formation are observed simultaneously with resorption of ceramic material. At later stages dense bone-ceramics connection is formed in implantation zone. Osteogenesis stimulation is achieved due to the usage of hybrid materials where osteoconduction characteristics of ceramics are combined with osteoinduction ones of skeletogenic cells saturating porous HA samples. Addition of silver ions to HA composition (one weight percent) does not break osteoreparation process but makes bactericidal effect. Corundum, HA and TCP ceramic grafts developed in the institute are broadly used during stabilizing reconstruction surgeries on various skeleton parts to treat inflammation, destruction or tumor defects. Good results were achieved in 82% of cases, satisfactory ones - in 10% and unsatisfactory - in 8% of cases.

Conclusions: The usage of grafts made of ceramic materials proves to be one the promising directions of spine surgery.

Key words: corundum, bioactive ceramics, bone morphology, spine surgery.

Perc.vertebral augmentation by intravertebral mesh and biologic graft in vert.compression

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This presentation is to discuss the percutaneous outpatient vertebral augmentation (VA) and reconstruction with a polyethylene intravertebral mesh (OptiMesh® Spineology, Inc., Stillwater, MN, USA) and biologic morcelized bone graft, the surgical indications, operating technique, case illustrations and clinical outcome. In the past vertebroplasty and kyphoplasty have provided excellent pain relief for vertebral compression fracture (VCF), but with a high incidence of complication; i.e., leakage of Polymethylmethacrylate (PMMA) into spinal canal or vasculature, cardiopulmonary complication, and adjacent vertebral fracture.

This percutaneous VA system, is designed, developed, and used for VCF treatment without above complications, and is a true biologic vertebral reconstruction. An OptiMesh® consists of, multi-strand polyester mesh or sac to be packed with specially ground bone chips or morcelized bone chips inside the mesh device to create a hyperdensed graft pack for restoring height resulting in pain relief.

This minimally invasive outpatient percutaneous OptiMesh® VA provides an efficacious and controlled delivery mechanism to stabilize and treat painful osteoporotic, traumatic and neoplastic VCF. In addition it can easily be used as an excellent intravertebral spacer and for intravertebral spinal fusion/fixation.

References
Spongioplasty: a new percutaneous method for osteoporotic fractures

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Background: The cement flow is difficult to check and control with conventional Vertebroplasty and the complications resulting may include extravasation of the cement into the spinal canal. However the Kyphoplasty is more secure but the cost are very high. That's why we developed a new Technique which is standing between the Vertebroplasty and the Kyphoplasty.

Methods: With the Spongioplasty Concept, the loss of spongiosa and trabecula is more homogeneously balanced. For this purpose a percutaneous route in local or general anaesthesia with the help of special access instruments is performed with a dorsal approach, pivotally transpedicular or extrapedicular, to the vertebral body. This is carried out under X-ray C-arm image control in 2 planes or optional with spinal navigation. The repositioning is made by a corresponding ventral sag of the spinal column, when positioning the patient. With the instruments correctly placed a bilateral biopsy is taken by suction of spongiosa. This creates a cylindrical space (3mm x 3mm x 35 mm) in the vertebral body, that allows for an optimal distribution of the bone cement. Under X-ray C-arm image control the viscous bone cement is then delivered in the vertebral body by a special applicator. The cement (PMMA) hardens inside in a few minutes. Through this it comes to an interior stabilization of the bone and pain relief.

Indications: Fresh osteoporotic fractures of lumbar, thoracic and cervical spine, tumors and vertebral haemangioma.

Results: We have operated 109 patients from January 2005 until February 2006, 80 female patients and 29 male patients. In the majority it was fresh osteoporotic fractures n=97. Prae-operatively 91% of the patients had severe till unbearable pains and 92% of the patients had post-operatively non to moderate pains. A reposition could be obtained from at least 2° (2° to 8°) in 47.6% of the patients. Clinical relevant complications occurred in 0.9% of the patients.

Conclusion: Fresh osteoporotic fractures have a good follow up after percutaneous Spongioplasty. The Spongioplasty is a very safty and cost-effective method which biomechanically allows a good cement distribution. Furthermore we reached through the ventral sag position of the patient a repositioning of the vertebra fracture.

Biomechanical performance of “spine pearls” in treatment of osteoporotic spine fractures

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Aim of the Study: Generally osteoporotic compression fractures are stabilised with PMMA cement using the kyphoplasty or vertebroplasty technique. The newly developed Spine Pearls are small metal bodies, which are implanted in the vertebrae through transpedicular cannulas. They are designed to be self interlocking and thereby stabilise the fracture. The aims of the present study were to investigate the stabilising effect and sintering behaviour of Spine Pearls in fractured vertebrae and compare them to conventional treatments.

Materials and methods: 15 fresh frozen thoracolumbar spine specimens (Th12-L2 and L3-L5, Øage=69) were evenly distributed in 3 test groups according to age and BMD. The three test groups were: Spine Pearls, Vertebroplasty and PMMA cement filled cavity created by the SkyBone Expander (similar to kyphoplasty). After weakening the lateral and anterior body wall, a controlled vertebral compression fracture was created by applying a displacement controlled eccentric axial compression force. Spine Pearls were implanted with pulsating shock waves induced by the plunger of the Pearl Driver. To assess the sintering behaviour of the different treatments, specimens were loaded in a servohydraulic material testing machine (MTS, 858 MiniBionix II) with a cyclic eccentric sinusoidal load in flexion. Three increasing magnitudes of cyclic loading (50-250N; 50-450N and 50-650N) were applied with 0.5Hz for 1000 cycles. The axial displacement of the actuator was recorded during loading.
The stabilising effect of the treatment was evaluated in a six degree of freedom spine simulator. Specimens were loaded with pure moments of 7.5Nm in flexion/extension, while the range of motion (ROM) in the treated segment was recorded using an ultrasound based 3D motion analysis system (Zebris). The ROM was measured for the following states of the specimen: intact, fractured, after treatment, after 1000, 2000 and 3000 cycles of eccentric loading.

Results: Stability: All treatments stabilised the fracture. However, none of the treatments was able to stabilize the fracture to the ROM of the intact specimens (p<0.05). During the course of cyclic loading the ROM for all treatments slightly increased. The three treatment groups all showed similar trends and none of the difference between the groups was statistically significant.

Sintering: After the first loading period (50-250N) all groups sintered approximately 2mm. With increasing load magnitude Spine Pearls sintered slightly more (4.5mm) than the two groups treated with PMMA cement (3.7). After 3000 load cycles Spine Pearls sintered on average 6.5mm, PMMA filled cavity 5.6 mm and vertebroplasty 5.3 mm. None of the differences between the three groups were statistically significant.

Conclusion: In the biomechanical tests Spine Pearls showed a stability comparable to conventional treatments. The sintering behaviour under cyclic loading was slightly, but not significantly higher than for conventional treatment techniques.

Dynamic stabilization / re-stabilization concept in degenerative disc disease

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In the last years we are experiencing a growing interest to treat the degenerative process involving the disc (mobile segment) earlier in its natural degenerative history. For this, several options and techniques exist and a lot is in the “pipeline” as clinical trial or experimental work in progress. In order to be truly less or minimally invasive in the treatment of lumbar DDD it is true that we should and must address the problem at a much earlier time point in the degenerative cascade. Based on our clinical experience and available data and therapeutic options, we have established a therapeutic plan depending on the stage of the degenerative process and the prevailing symptoms. We will present this lumbar DDD guideline paying special attention to:

A. disc regeneration or augmentation (early in the black disc phase) ie. ADCT, injectable nucleus-NUCORE
B. partial vs. total disc prosthesis (deg. Phase II) ie. NUBAC
C. DDD + microinstability (deg. Phase III) ie. micro/ percutaneous interbody restabilization
D. Stenosis (deg. Phase IV) ie. microdecompression + restabilization
E. Combined or mixed situations ie. black disc + microinstability

In our therapeutic strategy it is of primary concern the improvement of the patients signs (deficits) and symptoms (pain). It is not always the primary goal nor possible with a minimal –invasive concept to “cure” or change the underlying causes, eventhough standard procedures are being progressively replaced by operations performed percutaneously (ie. transpedicular fixation). Perhaps such guidelines can help us to carry out a multi trial approach to clarify and establish treatment concepts early in and for lumbar DDD amid the numerous possibilities.

Posterior motion preserving technologies in spinal surgery

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The concept of dynamic stabilization, compared to fusion, is particularly attractive one, especially for younger patients who would bear a greater burden on adjacent segments during their prolonged follow-up. In addition, its use does not restrict or eliminate any potential future therapeutic options. Interspinous implants share the mechanism of limiting extension of the lumbar spine and, as result, appear to improve clinical symptoms. The
Interspinous Implants act to distract the spinous process and restrict extension, having the effect of reducing the posterior anulus pressures and enlarging the neural foramen. The Interspinous Implants significantly reduced the mean peak pressure, average pressure, contact area and force at the implanted level.

The indications are:
1. Black disc-facet syndrome
2. Soft and/or foraminal stenosis
3. Lumbar canal stenosis after decompression (no laminectomy)
4. Large dimension lumbar disk herniations in young patients (7)
5. Topping-off (to prevent the junctional pathology)

The contra-indications are:
1. Tumours
2. Infections
3. Fractures
4. High grade osteoporosis
5. Instability (spondylolisthesis)
6. Not favourable spinous process anatomy
7. Intolerance to the material

Results and complications are described.

Conclusions: A recent issue in the Proceedings of SAS 2006 reports these conclusions that are completely agree with our experience: "In flexion the defect (bilateral hemifacetectomy with transaction of yellow ligament and transected supra- and interspinous ligaments) increase the ROM by less than 10%, in extension it lead to increase of about 30% above intact values. The Interspinous Implants with crimped wings restricted flexion by about 20% to 30% (compared to intact). Only the DIAM implant still allowed more motion in extension than the intact specimens. This has to be discussed with care because the implants lead to different kyphosis of the segments, most with the DIAM. In lateral bending and in axial rotation the ROM increased with our decompression model by less than 10% and stayed about these values with all implants." What will be the future? We present a new idea of an interlaminar device (INTRA spine) and we show the pictures and the post-op results of first implants.

Minimal invasive technique for dynamic neutralization
(Dynesys)

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The aim of dynamic neutralization is to realign and stabilize one or more linked vertebral segments in a position close to that of normal anatomical position, with the intent of fostering return to improved intervertebral motion physiology. Pain producing abnormal - “parasital” – motion should be limited and controlled, but not totally eliminated, and the motion segment should be reduct in a equilibrated “physiological neutral” position. The modulus of elasticity of the device was close to that of an intact spinal column. This internal bracing device enables the posterior elements, anulus and posterior longitudinal ligament to be placed under tension, repositions the articulating surfaces of the facet-joints.

At present time, over 3000 surgical procedures have been carried out worldwide, with a follow up to 10 years. In our department we perform this procedure since 6 years. Our experence in cases with Degenerative Disc Desease in 214 cases shows good and very good results in 80%. (PROLO-Score, VAS) In cases with s.c. “Postnucleotomy Syndrom”, the results are similar to those with fusion – namely 60%. Dynamic neutralization is potentially indicated for the treatment of all types of discovertebral instabilities during the dynamic phase of intersegmental degeneration.
Dynesys : alternative indications

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I’d like to talk about this: why I chose Dynesys and not any of the other devices used for no-fusion. I have chosen this device for 4 main reasons:
1) It is one and only pre-tensioned device which enables the intervertebral disc to regain its strengths and elasticity.
2) It stimulates the disc to regenerate itself and stop the process of degeneration as proven by Specchia,
3) For my situation : The study of 70 cases. I have had excellent results, 98% from the follow-up since 2001.
4) Finally the surgical technique proves to be as sure, reliable and simple as the instrument itself.

In the indications just like Dubois I cautiously started off with facts and not myths. We started with simple one-level cases which had been treated for disc hernia and for micro-instability. Consequently the indications have now been extended to cover even more complex and more demanding cases and always with excellent results seen during long-term follow-up. The alternative indications are relative stenosis regarding one or more levels, degenerative spondylololisthesis, including more serious cases 2 grade were well reduced, the failed back surgery post discus-hernia operated, the particular cases, the degenerative scoliosis in adults. I'd like to conclude with proposals for the future: I would be a good idea to study and improve this instrument in order to better combat these pathologies.

Actual trends in implant materials for lumbar dynamic restabilization

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Introduction: In recent years several methods for posterior dynamic stabilization of the lumbar spine were introduced to restore and/or maintain the segmental motion and to overcome certain disadvantages of fusion surgery. Current concepts that maintain motion but stabilize the segment, include both pedicle screw based systems and interspinous spacers. The purpose of this contribution is to discuss the material requirements in order to assure functionality and safety of such devices.

Requirements: The design of a non-fusion implant must address parameters such as range of motion, neutral zone, centre of rotation, pattern of motion, intradiscal pressure, disc height and deformation of the vertebral bodies. In order to fulfill these biomechanical requirements, the materials must withstand substantial static and dynamic compressive, tensile and shear stresses over a long period of time. In other words, the chosen materials must have appropriate elastic properties as well as sufficient static and fatigue strength in all three directions in space. In addition, the materials must be biocompatible and withstand chemical degradation in a physiologic environment for the entire lifespan of the implant.

Available Materials: Currently, only few materials are available that fulfill these requirements. Metals on one hand include titanium and stainless steel alloys as well as tantalum, whereas Polyethylene (PE), Polyester (PET), Silicone, Polycarbonate-urethane (PCU) with and without carbon fibre reinforcement and hydroxyapatite has recently been introduced as a coating material for pedicle screw fixation of dynamic stabilization devices.

Discussion/Applications: The posterior dynamic stabilization device with the longest clinical experience is Dynesys®. It consists of titanium alloy pedicle screws that are connected with a synthetic cord-spacer (PET-PCU) construct. These components provide stability to the segment while allowing a certain degree of motion [1]. Mechanical testing and clinical experience of more than ten years have demonstrated the longevity, biocompatibility and biostability of this device. Others attempt to achieve a stabilizing effect by connecting the pedicle screws with metallic spring elements. Dimensioning of the springs is critical in order to find the balance between the appropriate stiffness and sufficient mechanical strength. Long term clinical evidence of such devices has not been published to date. Currently there is a variety of interspinous spacers made of titanium alloy, silicone, and polyester or PEEK materials. It may be important that the devices have the appropriate stiffness with respect to the spinous processes. Wardlaw et al. suspected bone resorption adjacent to a
metallic device [2]. Some interspinous spacers are designed to act only in extension but others are also attached to the spinous processes to potentially limit flexion movements. Hence, for the latter devices the materials must also comply with tensile stresses. However, as the stiffness of each segment in each patient is different in all directions, the ideal range of stiffness for all of these concepts has not yet been established. Ultimately, only the long term clinical success can demonstrate the validity of the chosen parameters.

2. Wardlaw et al., Eurospine 2006

**Minimal access fusionsuergy without bone graft harvest**

A new bone graft substitute

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Autograft has traditionally been the gold standard for achieving a spinal fusion, but the morbidity is significant and the cost relating to harvest, hospital stay and pain management is underestimated. Allograft has to be appropriately tested and treated, and liability associated with using allograft of uncertain provenance makes it a less attractive option.

Growth factors require carriers, and although with BMP 2 the efficacy for achieving an interbody cage fusion is impressive, we cannot yet extrapolate this efficacy to all spinal sites. The results of other growth factors are less impressive [BMP 7], and the cost of these growth factors is very high. Off label usage in clinical situations other than ALIF cages makes Health Purchasers reluctant to fund them at this moment in time.

The so called ceramic graft expanders have been developed for usage in conjunction with autograft, and include Calcium Phosphates [beta-Tricalcium Phosphate B-TCP, HydroxyApatite HA] and Ca Sulphate CaS. Case series abound in the spinal literature, but comparative data is lacking.

The results of a comparative study of B-TCP [Vitoss], CaS and a new Silicated CaP [Actifuse] inserted into a NZW rabbit femur model show markedly superior vascular and cellular ingrowth at 1 and 2 weeks in the SiCaP group, with subsequent changes up to 12 weeks due to remodelling. In contrast, the CaS is resorbed so quickly it barely functions as a scaffold, and bone and vessel ingrowth is compromised by the lack of architectural support. It functions no better than the controls where the defect is drilled with no graft insertion. The B-TCP is resorbed more slowly, and the consequences of the resorption are the stimulation of phagocytosis that affects new bone as well as the scaffold, and the Ca and Phosphate ions released have an inhibitory effect on new bone deposition.

Early clinical cases are demonstrated using the Si CaP in an interbody setting without host bone, and in a posterolateral/facet setting where the synthetic graft is mixed with local bone reamings.

**Diam: principal & clinical experience overview**

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The aging process takes place within the vicious circle of the degenerative cascade. The motion segment degeneration determines the collapse of the functional spinal unit. The constraints' distribution change results from the altered weight bearing. With disc space narrowing the load bearing shifts to the articular process & laminae (Pollintine in Spine Vol 29 N° 27.2004) resulting in restricting the foramen (Crock in Clin. Orth. 115.1976). Because of the overloading, the neural arch resists to more of the compressive forces until the tip of the inferior facets impinges on the lamina below (Adams in Spine.1983). The overuse of the facet joints result in arthrogenic pain in spondylarthrosis. Surgical removal of whatever is pressing on the nerve root is emphasizing to the patient that the procedure is to relieve a pre-existing LB discomfort (Mariottini in Act. Neur. 2005). Segmental intervertebral distraction should provide room for root exit decrease disc bulge unloading the posterior column (Inufisa in Spine N° 19.1996).“The ideal amount of foraminal distraction”. The
balance of loads depends on the positioning of the fulcrum according to the Archimedes principle applied to the Roman balance. The center of rotation shifts toward the point of load application (Cossette). The deal was to find out a device which behaves as a pivot point for achieving segmental spinal balance. (Singh & Phillips in Dynamic reconstruction of the spine). A damper applied at the junction between the spinous process and the facets permits to reposition the facets, restoring the posterior tension-band and at the same time unloading the posterior part of the annulus through the "ligamentotaxis" (Guizzardi & Petrini). We were addressing the points that Pr. Moon has raised (in Spine Vol. 24.5) relative to the article of Minns (Spine. 22. 1997: Preliminary design and experimental studies of a novel implant for lumbar instability). Biocompatibility study achieved by M.B. Dekutoski. It was not observed any signs of reaction and wear. It was not reported any migration of the implant or loosening. A deformable system acts as a weight bearing assistance prosthesis allowing a better load distribution, without becoming stiff, and respecting the non linear behaviour of the FSU, during flexion/extension. According to mechanical testing results the aged DIAM showed reduced static & fatigue strength however still satisfies acceptance criteria for pre-aged device. (Szycher, Robinson in Concepts & application of Synthetic Biomedical Polymers. 1980). The kinematic study of an instrumented motion segment (F. Phillips) has been confirmed by a FEA (P. Maxy). The conclusion was that biomechanical studies suggest that the DIAM stabilizes the injured lumbar segment approaching motion of the intact one. The advantages of the posterior options are well know. In particular it permits to avoid potential complications of anterior surgery. Furthermore revision is a standard operation since the procedure does not burn bridges. Weight bearing lumbar pain results from discal instability and misalignment. The clinical evaluation of instability satisfies to three criteria (according to Kotilainen in Act. Neur. 1993). Minor instability may cause irritation of receptors, resulting in pain and muscular spasm. Osteophytes’s impingement & alternating force due to subluxation may lead to intermittent compression of the nerve root and vascular tethering (Garfin in JBJS. 81. 1999). The DIAM intends to deal with this pathology. We emphasize the importance of the intra-op. testing because of the lack of radiological evidence not always correlated with clinical symptoms & vice-versa. The instability is the resultant of the load applied and displacement produced (Sobei Ebara in Spine N° 17.1992). So patients with spinal instability present an abnormal intervertebral excursion when these are pulled up by a clamp branching their spinous processes. This test is repeated comparatively after applying the DIAM (De Villiers, 2006). A serie of 51 patients with a follow up of 4 years was integrated into the Henderson classification of functional results. For 97 % of cases, useful outcomes were obtained. Considering that within the process of the three points complex early degeneration, surgical intervention may be considered to alleviate disabling LBP. A series of 30 patients with 2 years of follow-up aged from 35 to 76 and displaying an as specific LBP, was been involved a retrospective study (Barbagallo 12th Eur. Congress of Neuroch. 2003) : An aspecific LBP is defined as a complex disc degenerative disease now responding and combined with a facet arthropathy. The results were very encouraging. It was reported by different authors, that about 75 % of patients operated for DH report residual LBP (the majority were under 40 years of aged). This fact has an explanation. Decompression of a disc prolapse offers good symptomatic relief but with the risk of biomechanical deterioration (Zollner & Carrajec 2003) with in over time display of unilateral stenosis (De Villiers 2006). To prevent these conditions the device was implanted in a sample of 50 such patients (Guizzardi & coll). At a follow-up of two years no patients showed any micro-instability, while less than 10 % of those tested reported any disabling chronic LBP. Lastly the VAS score varied from 3.5 to 1

Contrary to many hypothesis, interspinous distraction does not cause dramatically abnormal charges to the sagittal alignment (Okuma, Lindley in Spine Week 2004)

Over 40 years of ages disc degeneration is more pronounced & associated with degeneration of the articular process which cause irritation of mecanoreceptors & determine mostly a reduction of the recesses (Schiavone in It. J. of Spine disorder, 2003). Hyperlordosis is a promoting factor of degenerative stenosis (Smith JAM 1992) Retrolisthesis (pseudospondylolisthesis) is a dislocation in an anteroposterior direction (Schmol & Jurghans) requiring a stabilization. Two retrospective study were conducted for stenoinstability (By Dinoi, Petrini, Pupin, Delajoux). A gradual interesting improvement was noted for at least 18 months. Caserta was suggesting the term of combined stabilization. An elastic stabilization secures seems to reduce the concentration of stresses applied on the bordering disc during flexion by up to about 30 % (Eur. Spine Journal 2002). The "toping-off" was suggested in case of : annular posterior tear, black disk, subsidence above > 2 mm.

Lastly a multicentric retrospective study of 1000 cases with a follow-up between 2 to 5 years permitted to identify accurately the indication (SAS – NY 2005 Italian study) : black disk-facet symptoms, foraminal stenosis toping-off, large dimension lumbar disc herniation in young patient.

The contra indications for the DIAM are: a discal collapse > to 50 %, an overweigh .with a BMI < to 25 %, a diabet insulin-dependant, a torsional instability.

In conclusion: The DIAM assume a specific role in a stop-wise motion-sparing strategy in the management of the degenerative disease (F.Phillips). It would be much worse to prevent using DIAM in an unstable patient
who remains undetected by clinical and radiological selection (A. Mariottini). Elastic stabilization could be a good alternative to fusion in cases in which arthrodosis is an overtreatment (S. Caserta). Does not compromise possible further surgical treatment (A.M. Schiavone). Four prospective studies are in course. The objective is to demonstrate a clinical meaningful difference between both treatment groups study significantly higher with the spinal stabilization. Primary in the relief of LBP (VAS score) and secondary in the reduction of disability (Oswestry Index)

**Interspinous x-stop application under local anaesthesia in desperate indication**

_X-STOP interspinous distraction device_

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**Background:** Neurogenic claudication produced by lumbar spinal stenosis can be a severely limiting disease in the older population. Many have multiple co-morbidities and a number of these are accentuated by the inability to exercise and dependency of the lower limbs. These same co-morbidities can make these patients unacceptable risks for standard, prone surgical decompression +/- fusion with a general anaesthetic. The X-STOP device is a novel device providing distraction of the spinous processes and enlargement of the spinal canal without laminectomy. It can be inserted with the patient in the lateral position and can be undertaken using local anaesthetic.

**Methods:** The use of X-STOP in 4 cases is described. Three had been declared unfit due to multiple medical conditions. One refused general anaesthetic due to multiple procedures on the vocal cords. Ages were from 74-85 years. 2 were females, 2 males.

**Results:** The follow-up is 2-8 months. All had successful surgery. None had device related complications. All were ambulant the same day. All continued to have greater mobility than prior to the surgery.

**Conclusion:** The use of the X-STOP allows increased mobility in a group of patients otherwise not amenable to surgical treatment. In Australia access to new implants such as X-STOP is being hampered by Government restriction to medical benefits.

**Nucore: clinical evaluation of an injectable in-situ curing nucleus replacement**

One-year plus follow-up in 12 patients

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**Purpose:** Loss of disc material due to herniations and/or surgery can accelerate degeneration of the disc, and lead to significant loss of disc height and recurrent leg and/or back pain. NuCore™ Injectable Nucleus is an in-situ curing protein polymer hydrogel which mimics the properties of the natural nucleus. It is intended as an adjunct to microdiscectomy, replacing the natural nucleus lost to herniation and discectomy. The hydrogel is injected as a fluid through the annular defect, and adheres to the surrounding discal tissue as it cures. The material is designed to immediately fill the nuclear void and seal the annulotomy; and, in the long term, prevent recurrent herniation and further degeneration of the disc. This paper presents the latest data in an ongoing clinical trial of the use of NuCore™ Injectable Nucleus as a nucleus pulposus replacement in microdiscectomy cases.

**Methods:** Preclinical studies showed the device restores biomechanics, and the material is biocompatible, resistant to expulsion forces, and highly durable under simulated in vivo loading. A pilot clinical study is ongoing to evaluate NuCore™ Injectable Nucleus as an adjunct to microdiscectomy. At the time of this writing, the material has been implanted into sixteen patients aged between 23 and 51 years (8 females, 8 males) following a standard microdiscectomy procedure for monosegmental radicular pain non-responsive to conservative treatment. L5/S1 was treated in eleven cases and L4/5 in five cases.

**Summary:** All surgeries were successfully completed with an average injection volume of 1.2cc. An average of 71% of the tissue lost was replaced with NuCore™ material. An improvement in delivery method mid-study increased the amount implanted to 92% on average. Twelve patients are beyond one year follow-up and three
more are nearing one year follow-up. In all cases, pain subsided as normally expected following standard microdiscectomy. Neurologic evaluation, Oswestry index, SF36 and VAS scores were taken pre- and postoperatively, at six weeks, and three, six, twelve and 24 months post-op. All measures showed significant improvement in all patients. Average ODI scores dropped from 44 preoperatively to 8.1 at twelve months post-op. Leg pain dropped from an average preoperative score of 6.7 to less than 0.5 at twelve months post-op. The SF36 showed substantial improvement over preoperative scores. All of these improvements were maintained over the course of completed follow-ups. No patient had any device related complication. MRI investigations confirmed stable positioning of the implants at all time-points, and no re-herniations. Analysis of standing plain films indicated improved disc height maintenance relative to published literature, with an average loss of disc height at 12 months post-op of 9% percent.

**Conclusions:** To our knowledge, this is longest follow-up data available on the clinical use of an injectable nucleus replacement. All patients are doing well clinically, and disc height and function appear to be maintained over the course of follow-up. These clinical results indicate that NuCore™ Injectable Nucleus can be reliably used as a nucleus pulposus replacement, and that the material holds promise for improved long-term post-operative results for this relatively young patient population.

**Minimal invasive / open interbody distraction cage b-twin: experiences**

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Posterior lumber interbody fusion (PLIF) is more and more establishing as the “gold standard” in lumbar spinal fusion procedures. Besides all the advantages of this technique, some problems in introducing the cage through the spinal canal, such as excessive retraction of the dural sack and nerv-roots with possible neural damage and often sacrifice of the facet joints remain. Exactly this disadvantages are eliminated by the expandable cage (B-Twin). It is now possible to insert a cage by a minimal interlaminar approach exactly like operating a disc herniation. Because of its minimal diameter of 5 mm, it is possible to preserve the cranial half of the lamina, the interspinous ligament and the facet joint. Dural sack and nerval retraction is the same as in operating a disc protrusion because the folded cage, the dural sac and the trocar to insert the bone fragments all have a diameter not more than 5 mm, which correlates to the size of a medium disc rongeur. The author never uses the cage stand alone but always combined with a posterior instrumentation, either transpedicular or translaminar screws.

We focus on a very extensive disc removal and freshening, but not destroying of the end-plates. Further a sufficient bone autografting not only in the intervertebral area but also lateral to the facet joints at the base of the transverse process is importend. In addition we decorticise the facet joints and the interspinous contact with the aim of a 4 point circumferential bony fusion.

Based on our promising results with this cage and technique in 50 patients since November 2002, we recommend this procedure also for more complex situations like in very heavy patients, final segmental fixation in long thoracosacral fusions, hybrid constructions adjacent to dynamic stabilisation, a.o.

In this presentation the unique expandable titanium cage B-twin, our experiences with it and in addition the percutaneous application-technique described by the inventors of this cage are presented.

**News from lumbar TDR**

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25 years ago, a new strategy for treatment of degenerative disc disease started in Berlin/GDR with the development of the CHARITE artificial disc. This newly-created worldwide first Total disc replacement was an evolutionary step forwards. After seventeen years of application, the CHARITE Disc was approved by the FDA in 2004 as the first function preservation implant for the spine. Today, the golden standard fusion surgery has been ousted. TDRs have taken a legitimate place at the end of the treatment cascade of DDD.
Presently, there is neither an accurate definition of total disc replacements, nor is there an anatomically or biomechanically clear classification of TDRs themselves and in relation to other motion preservation devices. Best known are indications, contraindications and surgical techniques for applications of TDRs, less known are strategies for revision surgeries. Nevertheless, since about 4 years new ideas have appeared for improving the currently available lumbar TDRs and for further disc developments. The so-called second or even third generation of Total Disc Replacements started, with better adaptation to the spinal unit. There are at least two thinkable main strategies to accomplish this very difficult and maybe not definitely practicable target, depending on the design and material of the disc implants. TDRs with a new design are better targeted on physiological ranges of motion, including take-over of functions of the annulus fibrosus. The replacement of the ball-and-socket center of a traditional TDR by a specially shaped load transfer center with physiological ROM is one alternative of better adapted TDRs. Another possibility are specially designed edges of two or three component TDRs. In the long term, these TDRs protect facet joints probably better than currently implanted TDRs with unlimited rotation and no physiological extension and flexion as well as lateral bending amplitudes. The development of TDRs with material for simultaneous shock absorption has advanced. Within the lumbar spine however, the question arises of how far a loss of shock absorption simultaneously leads to a loss of intervertebral height in the long term. Experiences in the past have shown that the stability of the interface between the metal plates and the shock absorption material as well as the stability of the material itself have to be taken into consideration. Revision surgeries with revision implants are a special challenge in lumbar motion preservation disc replacements. In the last years, some companies have started to develop TDRs for (ventro-)lateral implantations. The prostheses are inserted after extensive dissection on only one side (usually the left) of the preoperatively narrowed intervertebral space. With ball-and-socket-type TDRs, postoperatively this probably results in angled intervertebral discs in frontal view with asymmetric loading of facet joints. A disc prosthesis with excluded lateral bending but at the same time physiological extension, flexion and rotation seems however to be suited for (ventro)lateral approaches in primary implantations as well as in revision surgeries.

Do we have gender specific differences for scales used in patient questionnaires?

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Aim: To find out gender specific differences working with scales to assess symptoms or disabilities in patient questionnaires.  
Introduction: It is epidemiologically known, that women report generally a higher level of pain in studies. Do they really feel more pain or do they have a different way to quantify? Pain is by far the most important symptom in spinal diseases. So it is important to have a simple and reliable tool to measure it. We have seen, that the VAS has a very low acceptance by the patients and the Likert is better, but the combination with a graphic grading is clearly the most preferred scale. So we wanted to find out which combined scale (verbal or numeric) is the most accepted.  
Cohort/Method: 84 persons (40 women, 44 men) were included and signed the informed consent. Average age was 48 years. The persons received two questionnaires, one with verbal and graphic scaling and one with numeric and graphic scaling in random order. They were asked to fill them out and report their preferences.  
Results: Every person could work with these scales, there was no misunderstanding. 81% of all participants preferred the verbal/graphic scale (VCS verbal). 19% preferred the numeric/graphic scale (VCS numeric). Analysing the subgroups we found gender differences. In the subgroup of the VCS numeric we had 3 females and 10 males instead of the expected nearly equal gender distribution.  
Conclusion: The result of the pilot study gave an insight of quantification differences in women and men. It has to be proven in larger series. The combination of a graphic and a verbal scale (VCS verbal) seems to be the most widely accepted scale by the patients.
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Our estimated industrial contributors to this course are in particular:

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