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Degenerative diseases of the lumbar spine have high medical and socioeconomic impact. With a prevalence of 60 – 90% is challenging for diagnostic imaging, arising from various imaging modalities. Different radiological diagnostic tools are available:

- **Native diagnostic**
  - standard images
  - special projections
  - functional projections
  - layer images

- **Contrast material / diagnostic tools**
  - myelography
  - spinal arterio- and phlebography
  - discography
  - computed tomography
  - magnetic resonance
  - PET scan

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 8 MRI machines (up to 3 Tesla) available in the near surroundings. Nevertheless we are planning an own equipment and we will start the implementation in late Summer 2008.

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.

Myelography, if necessary combined with CT, 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. Side effects of myelography are extremely rare and consists mainly in infectious or bleeding related problems could not be noticed in our large number of studies. Significant progress in CT hw an 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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**Diagnosis of spinal disorders: the radiologists’ point of view / risks in cervical nerve root blocks**

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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 inter-observer 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.

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Positional MR imaging: 30 patients with chronic low back pain were examined in a double-doughnut scanner which allows to obtain images in the upright position. Changes between body positions were relatively subtle. In a single instance, nerve root compression was diagnosed solely in the positional (extension) position.

1H-spectroscopy: 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.

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 having 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 joint (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.

References:

Cervical nerve root blocks, risk assessment

by Jürg Hodler MD MBA: a most actual case report

Within a time period of only seven months, two patients were admitted to our paraplegics center with the diagnosis of quadruplegia related to a cervical nerve root block. One injection had been performed at an outside institution, one at our own department of radiology. Both injections had been performed by experienced radiologists, using CT, with the needle positioned in the dorsal part of the foraminal entrance. The first patient was a 71 year old woman. Small amounts of bupivacaine (Carbostesin®) and diluted iotralan (Isovist®) as well as 1 ml of triamcinolone (Kenacort® 40) had been injected at the left C7/Th1 foramen. The second patient was a 58 year old man. 0.5 ml ropivacaine (Naropin® 0.2%) 0.5 ml iopamidol (Iopamiro® 200) and 0.5 ml of triamcinolone (Kenacort® 40) were injected at the C6/7 level, on the right side. Both patients started to experience excruciating pain shortly after the injection, followed by rapidly progressive quadriplegia. Follow-up MR images demonstrated ischemic changes to the cervical spinal cord. The neurological symptoms resolved progressively during the months after the injection but did not disappear completely.

Risk of severe side effects after cervical nerve root blocks:

Severe side effects after cervical nerve root blocks have been reported during the last few years as case reports, giving the impression of a rare event. In the May 2007 edition of Spine journal however, a survey was been published which indicated that severe side effects may be quite common after cervical nerve root blocks [Scanlon et al, 2007]. Based on a questionnaire sent to physicians with a number of different specialty trainings, they found a total of 78 severe side effects, including 16 vertebrobasilar brain infarcts, 12 cervical spinal cord infarcts, and 2 combined brain/spinal cord infarcts. Thirteen cases were fatal outcome.

There are some difficulties to calculate the true incidence of severe side effects because only approximately 20% of institutions participated, be-cause
• side effects may both be over- and underreported
• the authors did not inquire, if and what type of image guidance was used
• only Medicare data were available for calculations.
Based on some assumptions and third party information the incidence of severe side effects after cervical nerve root blocks is probably close to 1:3500.

Pathogenesis:
It appears that the events described above relate to the embolisation of non-soluble steroid crystals through arteries [Baker et al, 2003, Scanlon et al, 2007, Suresh et al, 2007]. Such arteries may be running in the posterior part of the intervertebral foramen. Huntoon [2005], in an anatomical study, found 21 posterior foraminal arteries in 95 foramina, some with potential direct communication to medullary vessels or the anterior spinal artery. Vascular communications have also been demonstrated by fluoroscopy. Furman et al [2003] found contrast within vessels in nearly 20% of cervical nerve root injections. 

It appears that the type of injected medication is important for the occurrence of side effects. Scanlon et al [2007], from their review, concluded that there was a relationship between infarction and particulate steroids such as triamcinolone. Karasek and Bogduk [2004] reported transient quadriplegia after an injection limited to local anaesthetics, contrary to the potentially permanent effects of steroid injections. Other potential problems occurring during cervical injections include dissection or spasm of the vertebral or other arteries, direct injection into the spinal cord, injection into the nerve root sleeve or into the dural sac. These complications, however, are not relevant for the two cases described above.

Risk management:
At our hospital, a panel session was organised, which included the relevant medical specialties (orthopaedic surgeons, spine surgery, rheumatology, neurology, anaesthesiology, radiology). The advice of a pharmacologist was available.

Recommendations at Orthopedic University Hospital Balgrist, Zurich:
Our panel decided on the following recommendations for our hospital:
- Indications of cervical nerve root blocks are limited to: Radicular symptoms, concordant with imaging findings (disc herniation), massive pain.
- Indications need to be confirmed by an independent physician trained in neurological assessments.
- Informed consent must include information about the risk of severe neurological side effects (estimated incidence: 1:3500).
- Instead of triamcinolone a water-soluble steroid is injected (such as dexamethason [Fortecortin®]). Although some clinicians believe that the effect of water-soluble steroids is less pronounced at least one paper by a well-known group does not support this concern [Dreyfuss et al. 2006].
- Only one level is to be injected per session.
- Cervical nerve root blocks can only be performed by staff members.

Additional discussions:
Other changes were discussed but not included in our protocol:
- Use of blunt needles
- Aspiration before the injection (only positive in approximately ½ of intravascular injections, Furman et al, 2003
- Very slow injection (minutes).
- Dilution of steroids before injection.
- Injection 1 cm lateral to the foraminal entrance.

Related procedures at the cervical spine:
- Facet blocks at the C0/C1 and C1/C2 are limited to surgical decision making (before potential surgical fusion at these levels). Explanation: Due to its complex course the vertebral artery is in danger of spasm or dissection. - Facet blocks at C2/3 to C7/Th1: The anterolateral access route with the patient supine, head rotated away from the injection site, is abandoned in favour of the less comfortable true posterior approach with the patient in prone position. Explanation: The anterolateral route is too close to the route used for foraminal injections.

References:
Anatomical basics in regard of minimal invasive lumbar spine procedures

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The cascade of lumbar motion segment degeneration includes 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 reflecting the dysfunction of the spinal segment. 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.

Intradiscal therapy and genetic engineering with the aim of decelerating, halting or even reversing this degenerative cascade, such as disc cell culture injection may become an alternative to fusion surgery. 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 exert enormous forces on the stabilizing anatomical elements.

In degenerative disc disease the impairment of nutrition pathways into the disc and the inability of the disc to dissipate toxic metabolic products, create an extremely hostile intradiscal environment with low pH, the formation of protease, cytokinines, prostaglandines, hypoxidity, dehydration, loss of proteoglycans and thereby turgor (swelling pressure). This toxicity leads to irritation of the fine nociceptive nerve endings which over the age of 50 penetrate the miniscule crevices of the endplate which thereby becomes painful. The toxic environment also causes necroptosis of disc cells. Disc cell cultures injected into degenerated discs have a rather limited number of life cycles. It therefore has been stated that biochemical and biological treatment should be complemented with mechanical measures that restore some of the normal kinematics and biomechanics of the motion segment.

In early stages 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=intraoosseous 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.

When tears of fissures sever the outermost annulus fibrosus, blood vessels are sprouting into the disc, frequently accompanied by nociceptive pain fibers (neovascularization). Larger and long-standing annular tears are typically sealed by a callus-type cellular granulation tissue which is richly vascularized and innervated. This granulation tissue is the pathoanatomical substrate of the High Intensity Zone (HIZ) that is frequently observed in the posterior central portion of degenerated discs on MR scans of patients complaining of non-dermatomal (mechanical) low back pain, "discogenic pain", but also in subjects without any such symptoms at all. Endoscopic and other minimally invasive treatment options for the various stages of DDD are discussed along with the pathoanatomical changes.

In the lumbar and lumbosacral spine the cascade of degenerative disc disease (DDD) is demonstrated in view of the currently available surgical treatment options. The pathoanatomy of "low-back-pain" and "radiculopathy" is mirrored against current treatment options, ranging from chemonucleolysis, percutaneous disc ablation, a variety of laser disc ablation options, coblation, and IDET, to hydrogel nucleus prosthesis, PDN, a wide array of fusion techniques such as cages for PLIF and ALIF applications, femoral ring and precision crafted allograft fusions and artificial disc prostheses. As an intriguing alternative, the concept of neutral dynamic, destructive stabilisation of the lumbar spine in painful mechanical dysstabilities and spinal stenosis in younger patients is briefly outlined.

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 back 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.
Changes in the microhemodynamics of nerve roots in lumbar stenosis during MISS

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Purpose: To ascertain changes in the microcirculation of nerve roots before and after retraction during lumbar interbody fusion surgery. We evaluate the blood flow at the site of the divergence from the dural tube through the use of a contact endoscope.

Subject & method: Subjects were 64 patients patients in the L4 nerve root in 3 patients and the L5 nerve root in 5 patients and S1 nerve root in 9 patients. Average age is 61.2 years. Procedure is TLIF-approach. Fusion cage is 14 mm diameter in 45 patients, 12 mm diameter in 19 patients retraction of nerve root is medial side. Software is our original Labo Library image analysis.

Result: The results of root sign analysis for these 12 patients were fair, according to MacNab's criteria.

Following nerve root retraction, the flow rate of erythrocytes through blood vessels decreased an average of 23.9%. Intravascular erythrocyte agglutination (IEA), where erythrocytes flow in clumps due to changes in the charge state of erythrocytes, was seen in blood vessels larger than 100 µm in three patients after retraction. Using a 150x contact endoscope, we were able to observe blood cells in vessels as small as about 20 µm in diameter in all 64 patients. According to MacNab's root sign result, decrease of central drift phenomenon is 68% in fair, 48% in good, 35% in excellent results. At the point of microrheology of Poiseuille's law, axial accumulation and axial drift phenomenon is to be analyzed by our original image guide software.

Conclusion: A contact endoscope was used to observe the microhemodynamics of nerve roots before and after retraction of the nerve root during minimally invasive surgery, and a decrease in the flow rate of erythrocytes was observed. 

CT guided infiltrations in the cervical and lumbar spine

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Epidemiology: Cervical and lumbar radiculopathy are common symptoms in clinical practice. Cervical radiculopathy is reportedly encountered with an annual incidence of 83 cases /100,000; lumbar radicular symptoms are encountered in 3-5% of the population. In the cervical spine disk herniation and spondylosis are the main causes of radicular symptoms. In the lumbar spine disk herniation, central spinal canal and lateral recess stenosis constitute the principal causative findings. Pain, paraesthesia, and motor/sensory deficits in the majority of patients resolve spontaneously or by conservative treatment with oral corticosteroid and nonsteroidal anti-inflammatory drugs and physical therapy measures. In 10%-25% of patients, however, radiculopathy tends to persist or continues to develop and become unremitting. Within the cervical spine, 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.

Pathogenesis: Spinal nerve root compromise may be due to acute compression usually by nucleus pulposus material or is related to chronic compression by osseous and discal components. Posterior longitudinal ligament tension, ventral meningeal irritation and root sleeve impingement are mediated by the sinuvertebral recurrent nerve branch. It transmits segmental somatic and non-segmental autonomic (sympathetic) impulses to the CNS. Symptoms derived from facet joint osteoarthritis are transmitted by the medial dorsal branch of the spinal nerve. The effect of acute and chronic nerve root compression may be further accentuated by venous congestion, hyperemia and neural edema. More important is the initiation of an inflammatory cascade by the leakage of nucleus pulposus substance. It is well established that chemotoxic substances such as phospholipase A2, cytokines (TNF), prostaglandines PGE2 and PGII, c-fos and matrix metalloproteinases are present in abnormal quantities leading to permeability increase of the capsule of the dorsal root ganglion (DRG). Accordingly increased concentrations of prostaglandins and leukotrienes (II 1β and II -6) are found in osteoarthritis of the facet and ilio-sacral joints.

CT guided technique: The rational of CT guided therapeutic infiltrations is to accurately deliver a high concentration of corticosteroid to the target site of the painful nerve root, facet or ilio-sacral joint. The steroid is aimed at reversal of the inflammatory cascade and reduction of functional impairment related to congestion.

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and edema; the local anaesthetic is directed to mitigate the neural responses via the sinuvertebral and posterior medial nerve branches. 655 CT guided infiltrations were performed in the MRI Institute in the year 2007: periradicular in 465, epidural in 53 and intra-periarticular facet and ilio-sacral joints in 137 instances. Cervical CT guided infiltrations: Contrary to fluoroscopy, CT guidance enables more precise and safe positioning of the 25G needle (0.5mm) used for injections along the cervical nerve root in the inferior interpedicular compartment and rarely to the epidural space. 0.5ml iopamidol 300mg/ml (Bracco) is injected to assess the distribution of injected fluid. Treatment results are best in foraminal and entrance point compression. Epidural infiltrations are performed with a 22G needle only: caution is required to avoid intra- or subdural needle placement for epidural interlaminar infiltrations. For cervical transforaminal epidural infiltrations, a recent survey (Scanlon GC et al SPINE 2007; 11:1249–125) disclosed 78 complications including 30 brain and/or spinal cord infarcts. Inadvertent vascular perforation with intraarterial injection of particulate steroids was deemed responsible for vertebro-basilar brain infarcts in 16, cervical spinal cord infarcts in 12 cases and 2 combined brain/spinal cord infarcts with a resultant fatal outcome in 13/30 patients. One of 78 complications occurred under CT guidance, 70 in conjunction with fluoroscopy and in 7 instances reportedly no imaging assistance was used. Dexamethason injections were not afflicted with complications. Water soluble dexamethason (5-10mg) therefore is employed for cervical transforaminal and interlaminar epidural injections (consensus meeting by Prof. J. Hodler, Balgrist Hospital Zurich). No statistical difference was reported in 30 patients with cervical radiculopathy randomly assigned to 12.5 mg dexamethason or 60 mg triamcinolon treatment at 4 weeks control (Dreyfuss P etal. Pain Med 2006;7:237–42).

Lumbo-sacral CT guided infiltrations: In our institution lumbo-sacral transforaminal and interlaminar epidural injections are performed by 22G needle using triamcinolon 40mg in conjunction with 0.5-1ml bupivacain 0.5% (Carbosthesin), for facet joints 10 mg trimecinolon + 0.5ml bupivacain. Overall 1 transient episode with monoparessis and one vasovagal reaction was encountered in conjunction with lumbar infiltrations only. CT guidance allows targeted pathology adapted selective application of medication in intraforamal, 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. Results are better when the preganglionic nerve segment is reached by an epidural infiltration and when symptoms prevail for less than 3 months. CT guidance facilitates targeted therapy in patients with previous surgery compared to fluoroscopy guided treatment. CT imaging allows adapting the infiltration to altered anatomy caused by scar tissue, recurrent disc herniation or progressive osseous compression. Multilevel radicular symptoms and sciatica are indications for an epidural steroid injection. Based on our experience - in concurrence with others - the epidural treatment is effective in sciatica. 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.

Conclusion: In patients with radicular and/or ilio-sacral/facet joint symptoms resistant to conservative measures CT guided infiltrations are beneficial provided a meticulous and safe technique is applied. MR and CT demonstration of an anatomic substrate and exclusion of other causes is a prerequisite to a distinguished treatment plan and successful therapy. ◆

Percutaneous radiofrequency medial branch neurotomy for chronic neck pain

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Cervicogenic headache, migraine and tension type headache may have head and neck pain and other symptoms as the same clinical findings. Despite the same pain pattern, all three diseases emerge from different pathology. In the case of cervicogenic headache, medical history, clinical manifestations, radiological findings and diagnostic blocks, can provide the best possible diagnosis. The diagnostic method of choice is the infiltration of the medial branches of the cervical dorsal rami innervating the zygapophysial joint, not the joint itself. Only small amounts of local anaesthetic (0.3 - 0.5 ml) are used, showing significant, repeated complete pain relief.
Differential diagnosis is important and mandatory, because migraine, tension type headache and cervicogenic headache - originating from zygapophysial pathology - require a completely different therapeutic approach.

Treatment for migraine and tension type headache is medical, physical and behavioural therapy. In cervicogenic pain medical therapy is effective only in a limited number of patients and long term therapy with WHO I and II analgesics is not well tolerated. For these patients with demonstrated cervical zygapophysial joint pain, percutaneous radiofrequency (RF) neurotomy of the medial branches of the cervical dorsal rami is a pain relieving intervention, resulting in long lasting pain relief.

The interventional diagnostic procedure is a two phase cervical medial branch block under computed tomography (CT) guidance at the affected cervical joints. After reproducible, significant pain relief (more than 80% on a visual analogue scale), RF neurotomy at 80°C for 75 sec is performed at each cervical level using CT guidance, sensory and motor testing for cannula placement.

Outcome data are conflicting. The first randomized controlled, double-blind trial was showing long lasting pain relief after medial branch neurotomy following the procedure described (1). In contrast a systematic review only found limited evidence for long lasting effectiveness (2). In studies from routine clinical practice, RF neurotomy is an effective treatment for chronic cervical zygapophysial joint pain (3).

Although cervical RF neurotomy is not always successful, it is the only intervention for head and neck pain that has been shown to be capable of providing complete pain relief, in patients suffering from cervical zygapophysial joint pain, when conventional treatment has failed.

In summary, percutaneous medial branch neurotomy of the cervical zygapophysial joints needs differential diagnosis and a strict interventional diagnostic procedure to be a successful treatment for head and neck pain.

Literature:
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Intraoperative 3-D-imaging for spinal navigation: CT or the 3-D-C-arm?

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Background: Screw fixation is an established technique for spinal and fusion. However, it is important to ensure that the pedicle screws remain in the main axis of the pedicle, and do not invade the vertebral foramen or spinal canal.

Despite the various benefits of spinal navigation in pedicle screw insertion, there is still a high rate of screw misplacement, which ranges from 2.7% to 14%. Thus, we cannot recommend that navigation with registration based on anatomical landmarks and surface matching as a standard technique particularly in cases of unstable spinal fracture. The term ‘screw misplacement’ is taken to mean a perforation of the pedicle and vertebra by the pedicle screw of more than 2 mm (deviation ).

This presentation presents an improved method of intraoperative navigation, using marker screws for registration implanted in the vertebrae at the beginning of surgery, before acquisition of the data set used for intraoperative navigation.

This has become possible due to the availability of intraoperative CT, and provides better application accuracy than techniques based on anatomical landmarks. Additionally we have the first experience with intraoperative 3D-C-arm imaging and a automatically registration procedure.

Methods: All of the operations were performed with the aid of a Tomoscan M mobile CT system (Philips Medical Systems, Eindhoven, the Netherlands). The system comprises a mobile gantry, a mobile patient examination table and a mobile workstation. An infrared sensor navigation systems was used: the SurgiGATE (Medivision, Oberdorf, Switzerland) and the Stryker navigation system (Stryker, Freiburg, Germany). All of the surgeries were performed with the patient positioned on the mobile table of the CT system or on a fixed carbon table. Following dorsal preparation of the vertebral region, the surgeon implanted small titanium screws in the vertebrae. The screws served as fiducial markers. Image data acquisition and image-to-patient registration were performed after implantation of the marker screws. The
pedicle screws were inserted using the navigation system, and the position of all implants was confirmed by intraoperative CT scans. For the spinal navigation with the 3D-C-arm we used the BrainLap Navigation (Heimstetten, Germany) system VectorVision fluoro 3D spine and the 3D-C-arm from Siemens ARCADIS Orbic 3D (Feldkirchen, Germany).

Results: The combination of intraoperative computerized tomography and spinal navigation allows easy navigation with a high application accuracy of 0.8 mm ± 0.4 mm (SD) at the target point (measured in experiments with a plastic spine model). In a experimental study of percutaneous spinal navigation we reached an application accuracy of 1.2 mm ± 0.6 mm (SD). 304 patients with various spine disorders have been operated upon using the technique described, and 1438 pedicle screws have been inserted. The pedicle screw misplacement rate was only 0.9% but using the navigation technique without CT (n=21) we achieved a misplacement rate of 9.2%. The evaluation of 3-Dimensional registration method for spinal navigation showed a mean entry point deviation of 1.3 mm +/- 0.57 (range 0.6-2.8 mm) [Tanner, P et al]. They found a deviation of 1.5 mm +/- 0.79 (range 0.4-3.2 mm) for the target point. The mean transverse screw angle deviation showed 3.8° +/- 1.8° (range 0-6°).

Conclusions: Screw fixation using intraoperative CT and fiducial marker screws provides much better application accuracy than the previous technique using anatomical landmarks. The possibility of performing an intraoperative quality check improves the safety of these procedures. We presume that the minimally invasive navigation-guided percutaneous technique will become increasingly important in the future. The use of the 3D-C-arm and the automatically registration procedure has a sufficient application accuracy. In comparison to the intraoperative CT the advantage of this technique are the lower cost and the faster procedure and the disad-vantage is the worsen image quality of the bone structures without information's regarding the soft tissue. ◆

Minimal invasive approaches to the anterior lumbar spine/thoracolumbar junction

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The use of anterior approaches to the lumbar spine and especially to the thoracolumbar junction is known to be associated with a significant surgical trauma, a high postoperative morbidity and occasionally high complication rates.

Because of the decreased trauma in anterior surgical approaches to the spine, minimal invasive techniques have been used more frequently in last years. The procedures are more or less modifications of the standard anterior approaches. So it is possible to reach the lumbar spine and the thoracolumbar junction by a minimal invasive retroperitoneal (extrapleural) technique. The techniques are associated with mostly negligible surgical trauma, a low intraoperative blood loss and decreased postoperative morbidity and recovery time. ◆

Disability in low back pain

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We are trying to get patients back to work and off disability, both for the sake of the patient and society.
1. What can governments do with legislation?
2. What can society do?
3. What can doctors do for individual patients?

At government level there are things that can be done, but first what is the size of the problem? In the United Kingdom in 2000, 125 million day were lost to work from back pain. Some countries have had some success, Sweden, Singapore, Australia and Canada & the Netherlands. In the Netherlands in 1993 there were 80 people on benefit to every 100 in work. Each worker was supporting one other. Of that number 22% were on disability of which a third were backache. Australia and Canada have attacked the cost of back pain from road traffic accidents; they have decriminalised them. As a generalisation leg pain should be curable.

MRI scanning is taken by the general population to be the absolute answer to back problems. Many family practitioners will send patients to hospital to have an MRI with no idea why or how to use the information.
There have been many good papers of MRI scans on symptom free people who have abnormal scans. The other great red herring is Spondylolisthesis and Spondylolysis. Isthmic Lytic the most common type occurs in 4-5% of normal Europeans going up to 50% in Inuits & they are symptom free. Pain can usually be controlled with nerve route blocks, allowing an episode to resolve. There is no relationship between the size of disc and pain. The most difficult problem is unremitting back pain going on to long term disability. If a patient insists they have back ache and will not return to work there is little one can do to make them other than financial coercion. The classic treatment was spinal fusion, but happily this has fallen under grave suspicion. In the Swedish Lumbar Spine Study, spinal fusion was slightly better than no treatment at all. All types of spinal fusion gave the same results, but the complication rates were very different.

- Postero-lateral fusion 12%
- Instrumented postero-lateral 22%
- 360° fusion (Anterior and posterior) 40%

In the UK we did a prospective trial of spinal fusion against 3 weeks of intrusive inpatient rehabilitation. The outcome measures used were
1. S.F. 36
2. Oswesty disability Index
3. Shuttle walking test
4. Visual pain score

At the end of the 5 year period there was no difference and the rehabilitation was slightly cheaper. What one is trying to achieve is a cheap treatment with a low complication rate and high return to work. Back pain is not a disease; it is a bio-socio-economic episode. The higher the intelligence and wealth of the patient, the better the recovery. When work is more satisfying, the home conditions better and the finances seem easier. The recovery is better. The sooner treatment is started the better the results. Unfortunately in the UK NHS the wait for back pain treatment is 6–12 months, by which time the pain is centrally fixed. If there is an economic incentive not to return to work the results are even worse. Virtually all papers on spinal surgery show worse results in workman’s compensations cases. Back ache is not a specific diagnosis with a specific treatment. It is economic with very little biology.

MIESS: A Surgeon’s perspective and emerging technical considerations

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Abstract: Degenerated lumbar disc and spinal stenosis are common problems requiring decompressive lumbar surgery. Open spinal discectomy is associated with significant morbidity, long-term convalescence, prolonged general anesthesia and wide dissection of tissues that can cause bleeding, scarring and eventual destabilization of spinal segments. The evolving less traumatic minimally invasive endoscopic lumbar decompression procedure is free from these potential complications. Therefore the pursuit of minimally invasive spine surgery (MISS) began. The pioneering effort and innovative contributions were made by Lyman Smith, Hijikata, Parviz Kambin, Adam Schreiber, Hj. Leu, and others.

This endoscopic spine surgical procedure, its surgical indications (for treatment of herniated lumbar discs, post fusion junctional disc herniation, neural compression, osteophytes, spinal stenosis, vertebral compression fractures, spinal tumor, synovial cysts and etc...), its operative techniques (both transforaminal endoscopic approach and interlaminar endoscopic assisted approach) including tissue modulation technology (i.e. laser and radiofrequency surgical application) are presented.

With increased utilization of complex high tech and digital technologies, and instruments in the surgical suite, it requires seamless connectivity to perform the surgical procedures, in a precise and orchestrated manner. SurgMatix®, a new integrated image-data based OR control system has been developed and utilized to facilitate this outpatient endoscopic spinal surgery. This system is designed to promote seamless integration of all aspects related to the surgical procedure and to reduce surgical time and personal requirement significantly. This ease to use SurgMatix® system creates organized control instead of organized chaos.

The surgical result has been extremely gratifying for both the patient and the surgeon. There was no postoperative mortality, and morbidity of less than 1%. However, the potential risk and potential
complications will be discussed. Transforaminal endoscopic microdecompression can effectively decompress herniated discs and spinal stenosis with foraminoplasty for treatment of spinal stenosis. It also provides an excellent and effective access or platform for spine arthroplasty, spinal disk replacement, artificial disk, vertebralplasty, spinal fixation/fusion, disc re-growth technology and perhaps genome therapy. Obviously, this minimally invasive, less traumatic, outpatient endoscopic MISS treatment leads to excellent results, faster recovery, and significant economic savings.

References:
Endoscopic lumbar disc surgery: its uprise and actual foraminoscopic concept

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After a decade in clinical experience in percutaneous 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-scope 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 180 standardized cases brought successful primary results in 149 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 accour 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 can trace the access precisely. Detailed knowledge of foraminal anatomy is mandatory. Hospital stay could be reduced to 2 to 3 days, out-patient care is possible nowadays as well. Other pioneering 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 established endoscopic lumbar disc decompression techniques in trained hands.


EMG-monitoring & navigation in transforaminal endoscopic disc surgery

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Introduction: Access to anatomic structures in percutaneous dorso-lateral, endoscopic assisted monoportal disc surgery may vary in individual patients, and special techniques may be needed to gain access and to avoid injury to spinal structures. A major limitation of endoscopic disc surgery, especially in removing lateral fragments, is the fact that that it is usually performed under local anesthesia because the patients full cooperation is required to give continual information on radicular symptoms. To reduce stress on both the patient and the surgeon we can perform the surgery under general anesthesia with free-run electromyography recordings from characteristics muscles for the nerve root exiting through the foramen. Abnormal EMG changes in the form of spikes or bursts were recorded in case of direct contact, through traction or newly in evoked electrical stimulation of the exiting nerve root. On the other hand radiological considerations are important in determining the so called excursion zone. Therefore and in addition we present a navigational study showing the limitations of the system in means of disc level, orientation of the facet joints, and in terms of the cannula entry point. Technical notes: We used the VectorVision2 of the BrainLab navigation system. A CT-scan of the pathological segment was matched with conventional intraoperative X-rays in two planes (CT-Fluoro Matching). After this procedure we could calibrate the endoscope, allowing a visualisation of the scope from the entry point to the disc and to the spinal canal and spinal foramen in multianplanar orientation. Results: Targeting foraminal and extraforaminal disc herniation in every disc level, even in L5/S1, is feasible.
Removing of the fragments under visual control is possible and allows the complete decompression of the exiting nerve root. Medio-lateral disc herniations with clearly visualisation of the traversing nerve root can be targeted in upper lumbar segments (L3/4-L1/2) using a 45° entry angle of the scope. In relation to the anatomical orientation of the facet joints these herniations can be accessible with a far lateral approach in L4/5. Visualisation of the spinal canal via this approach is impossible in L5/S1. Using a more cephalad entry point of the instruments a visualisation of the lateral recess is feasible at which in L4/5 and L5/S1 bone resection using a drill or laser application is necessary.

Transforaminal endoscopic spine surgery (TESS)

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Background: The purpose of this paper is to present a new endoscopic surgical procedure, the Transforaminal Endoscopic Spine Surgery (TESS), with a posterolateral transforaminal approach under endoscopic control and with minimal aggression to the surrounding tissues. This procedure consists of a new method of reamed foraminoplasty done under full endoscopic control while using a new endoscopic 3.5mm bone reamer for undercutting the superior facet.

Methods: Forty-four consecutive patients with foraminal stenosis underwent transforaminal endoscopic surgery (TESS) between March 2005 and July 2007. Inclusion criteria for TESS Surgery were: Unilateral radicular leg pain associated to foraminal stenosis. Inadequate response to conservative treatment for > 6 months. All 44 procedures were performed by the posterolateral transforaminal approach under endoscopic control. Bone reamers were used in order to perform foraminoplasty to allow the access to the intradiscal space or to the intracanal space. In all cases of foraminal stenosis with unilateral disc collapse and unilateral radiculopathy a reamed foraminoplasty was performed in order to decompress the exiting nerve root. Herniated nucleus or fragments, if present, were extracted. Results: Pain was scored with a Visual Analog Scale (VAS) and the disability was evaluated with the Oswestry index for every patient. The scoring and indexing were performed pre- and post-operatively. The postoperative scoring and indexing were updated every 3 months to achieve a minimal follow-up of 1.5 years for every case. The outcome of these 44 operated patients was: 28 excellent (63.8%), 9 good (20.5%), 4 fair (9.1%), 3 poor (6.8%).

Conclusions: All 44 patients in this study were operated using a new endoscopic 3.5mm bone reamer for undercutting the superior facet under direct endoscopic vision. It is to be remarked that 29 patients were operated at level L5-S1. This proves to be a new promising technique, as it is very useful for narrow foramens in which the access is generally very difficult.

Full-endoscopic surgery of the spine with interlaminar/dorsal approaches

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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. New optics have been developed with a wide working channel for spinal surgery which enable sufficient bone resection using burrs under visual control. These days, there are various full-endoscopic techniques available which can supplement each other: for the lumbar spine there is the posterolateral to lateral transfuraminal as well as the interlaminar access; for the thoracic spine, the posterolateral transfuraminal and the interlaminar access; for the cervical spine, the anterior transdiscal and the posterior access. There are specific advantages and disadvantages for all of these techniques. The transfuraminal access can be preferred, since it can be performed atraumatically. Nevertheless, mobility problems may arise. Here, the interlaminar procedure can expand the spectrum and enable operation of all disc herniations and lateral spinal stenosis, and in the thoracic spine special lateral disc herniations. In the cervical spine, the dorsal access enables therapy of all lateral disc herniations and foraminal herniations. Unlike the anterior transdiscal procedure, which is the only treatment available for medial pathologies, the disc is not damaged and mobility is expanded.

Considering the indication criteria, now the combination of full-endoscopic approaches with the new developed endoscopes and instruments provides sufficient decompression under visual control of lumbar, cervical and thoracic disc herniations and spinal stenosis. 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 the indication is broadened with respect to techniques for spinal canal decompression.

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.

Minimally invasive spinal techniques using tubular

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With the development of new surgical techniques, materials and instruments, spinal surgeries became safer and postoperative outcomes became more predictable and consistently better. However, in a significant number of patients, in spite of an appropriate indication and skilled surgical technique, clinical results are not as good as expected and patients complain of persistent symptoms and disability even when postoperative images don't show neural compression or evidence of complications. Paraspinal muscle destruction/denervation has been implicated in some of this postoperative disability and less invasive surgical techniques have been developed. The authors present their experience performing paramedian muscle-splitting techniques using sequential dilators and a tubular working channel. This technique was used in 39 patients for cervical laminoforaminotomies, removal of lumbar disc herniations (intracanalar and transfuraminal approaches), lumbar decompresssion (central, lateral and foraminal) and posterior lumbar arthrodesis, both posterolateral and interbody (PLIF and TLIF). Indications and limitations of the technique are stressed and some tips and tricks are pointed out. For lumbar arthrodesis (the more common procedure in this series), this technique produced significantly less blood loss, less consumption of analgesics in the postoperative period and shorter hospital stays when compared with the classical open approach. The complication rate was similar, as was the operative time.

In conclusion, the authors believe that mini-open approaches using muscle-splitting techniques and tubular retractors allow achieving of a wide range of surgical aims, including the vast majority of monosegmental procedures. Perioperative blood loss and postoperative course compare favourably with those of the classical open techniques.

Radiofrequency: application in lumbar ddd with the „3 in 1“ technique

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Chemonucleolysis and percutaneous discectomy as well as laser decompression and discectomy are used methods besides the rapidly developing endoscopic techniques as minimal aggressive techniques for discal
pain syndromes. In recent years, the use of high radiofrequency energy was added to this spectrum. Every
technique from thermocoagulation for annuloplasty to the “coblation” must be considered as unique
procedure. A new minimally invasive technology for the treatment of discal diseases of the lumbar spine
with high radiofrequency based on the extensive use of the percutaneous RF-techniques and and positive
experiences with use in endoscopic spine surgery has been developed to recombine the advantages of the
different methods in one minimal invasive surgery.
The purpose of the presentation is to assess the potential of this highradiofrequency based combination
procedure. First we will discuss basic investigations for the efficiency and safety for this procedure. Then we
will present our clinical results demonstrating the surgical technique with the special assessable probe in a
controlled prospective study.
Methods: For this first prospective outcome study 66 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 in different cultures and investigated the outcome
postoperatively, after 6 weeks and 6 months by a standardized protocol partly by independent investigators.
Beside the clinical results two scores has been observed.
Results:The VAS is demonstrating an improvement from 8,6 to 1.9 two days postoperative, 3,5 after 6weeks
and 3.3 after 6 Months. The SLRT and the neurological deficits improved significantly. The McNab index is
showing on av. an excellent outcome postoperatively and a good after six weeks and six months, as well as
the Andrews and Lavyene Score. Until now there has been no complications.
The first results encourage us to include this procedure in our spectrum of minimal invasive spine surgery
be comparable to the other minimal invasive procedures avoiding an open surgery and to fill the gap in the
cascade of treatment of discal disorders. The combination of different techniques in one procedure mark an
advantage and seems to be superior to a single technique. Cause of the smaller instruments it is less
invasive than an fullendoscopic procedure by the marked indications, but an endoscopic assisted controll is
possible. ◆

The translaminar approach to cranially extruded lumbar disc herniations

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Objective: A prospective, non-randomized study on the translaminar approach (TLA) for the treatment of
cephalad extruded disc fragments impinging the exiting root.
Methods: Between May 2000 and July 2004 hundred-four patients (59 males) presenting in 74 % of the
cases an upper lumbar root compression underwent TLA. The mean age was 57 years (range 27-80 years).
Surgical technique: The lamina was approached either through the conventional subperiosteal route or via a
muscle splitting access. Through a translaminar hole of 10 mm diameter mostly intraforaminal disc fragments
were removed. The disc space was cleared in case of an evident perforation of the annulus. Follow-up
examinations were performed by an independent observer at one and six weeks; three, six and 12 months
and once yearly thereafter (mean follow-up 32 months).
Results: Intraoperatively, extruded (61%) or subligamentous (39%) disc fragments were found. Laminae L4
(44%) and L5 (26%) were mostly involved. In eight cases the translaminar hole was enlarged to a
conventional laminotomy. In 13 patients the disc space was cleared. The outcome according to the MacNab
criteria was excellent (67%), good (27%), fair (5%) and poor (1%). The incidence of recurrent disc herniations
was 7 %. Functional x-ray films performed 6 months after surgery in the first 20 patients of the series and in
further 12 patients complaining about postsurgical back pain excluded any instability.
Conclusion: The TLA is recommended in disc herniations encoaching the exiting root as an alternative to the
conventional interlaminar route. ◆

Percutaneous endoscopic discectomy via transflic transforaminal approach in L5/S1

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Introduction: Transforaminal percutaneous endoscopic lumbar discectomy (PELD) is one of the widely used
 procedures especially above L5-S1 level. Instead of transforaminal approach, the greater part of the
intraspinal canal disc herniation at the level of L5-S1 can be easily accessed via interlaminar approach. But,
in some conditions, transforaminal approach can be thought to be better than interlaminar one although the former is limited because of the anatomic constraints. The purpose of this study is to introduce transiliac transforaminal approaching portals for L5-S1 disc herniation, to suggest its indication, and to evaluate the clinical results.

Materials and Methods: Until now, we have experienced five cases of lumbar disc herniation which were treated using transiliac transforaminal approach. Four cases were central extruded herniation and were approached on the side which the symptoms were more dominant. One case was recurrent disc herniation after microdiscectomy and were accessed on contralateral side to avoid scar adhesion resulted from previous operation. Performing the transiliac approach, we used 1cm-diametered drill to make an osseous canal through the ilium under fluoroscopy. Postoperative CT was taken to evaluate the approaching canal. Clinical outcomes were evaluated by the improvement of preoperative pain.

Results: In four cases, transiliac approach was successful and preoperative radiating pain was improved. Low back pain score was improved from 41 points preoperatively to 97 points postoperatively. Numeric rating pain scale was 1.3 against 10 preoperative reference values. In one case performed this technique under local anesthesia, approach was converted from transiliac to interlaminar portal due to inappropriate osseous canal. The case underwent contralateral approach developed paresthesia resulted from the exit root injury by direct contact of drill. There were no problems related to the site making the iliac osseous canal.

Conclusions: Endoscopic transiliac transforaminal approach for L5-S1 disc herniation was successful and can be good option in condition with huge central disc herniation associated with bilateral symptoms, recurrent disc herniation, or foraminal herniation at L5-S1. But, it must be remembered this technique needs a great caution to create an accurate transiliac tract.

**Percutaneous cervical disc decompression**

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The study was designed to determine the indication of the Percutaneous cervical disc decompression (PCD) and choosing appropriate procedure and inform the surgeons about patient selection. Controversy remains in the treatment of cervical radicular as well as low back pain. Most of Surgical treatment options gave different morbidity and results. Open surgical techniques have high morbidity rates compared to minimal and less invasive options. Unless patient selection was not done properly in PEC, complication rates could be more than the open surgical techniques.

Percutaneous endoscopic cervical interventions may have more reasonable results compared to lumbar interventional treatments. Advantages of the PEC are awake anesthesia, easy approach and short operation time with high patient satisfaction. Any of percutaneous applications are useful to reduce intradiscal pressure, relieve pain. We simply divided PCD needle interventions and safe tube applications. Needle applications; consist of chemonucleosis and IDET. Laser, RF and automated disc decompressor could be performed by safe tube as well as endoscopy.

Peroperative discography is the most important diagnostic method to select the type of procedure. Selective endoscopic discectomy allows us to remove fragments and decompression. Appropriate indications were determined by MRI evaluation and correlation with clinical signs. Basically the surgical technique is not so complicated and learning curve is low. Our suggestion to surgeons to focus on aiming to herniation and to use navigation systems.

**Minimally invasive therapy for all kind of disc herniation : 7 years experience in Brazil**

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Study Design: Three different kind of minimally invasive techniques were used to treat all kind of lumbar disc herniation.
Objectives: The goal was to evaluate the effectiveness of three different kind of lumbar disc herniation with three different kind of techniques.

Summary of Background data: The lumbar disc herniation is a benign evolution disease and about 90 to 95% of the patient can be treated with the conservative measures. However, when the surgical treatment surgical is indicated there is a great controversy about the best technique. Microdiscectomy gives broadly comparable results to open discectomy. The evidence on other minimally invasive spine surgery techniques (MISST) remains unclear (with the exception of chemonucleolysis using chymopapain, which is no longer widely available). However, with the fast technological development (diagnostic and instrumental), the MISST continuous fascinating the spine specialists. The author selected three different kind of MISST to treat all kind of lumbar disc herniation with the objective of to minimize the aggression and to maximize the clinical result.

Methods: Basically, there are two different kind of lumbar disc herniation (LDH): contained and non contained. The non contained disc herniation is subdivided in: foraminal and extraforaminal, central and centro lateral. Since 2000 we have been doing coblation assisted percutaneous disc decompression (NucleoplastyTM) to treat contained LDH. Transforaminal endoscopic technique (YESS) for foraminal and extraforaminal non contained LDH and interlaminar endoscopic technique (Endospine) for extruded and sequestred LDH.

Conclusion: Our study began in 2000 and it will finish in the end of 2007. After which a definitive study about the clinical outcome will be done. However, the preliminary results of the first 400 patients treated with these techniques are encouraging and seems to be better if compared with the macro or the microdiscectomia.

Natural history of postoperative CRP and LC levels after open/endoscopic surgery

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Purpose: Despite the fact that C-reactive protein (CRP) and leukocyte counts (LC) are routine blood chemistry parameters for the early assessment of wound infection after surgical procedures, little is known about the natural history of the serum levels after large and minimally invasive spinal procedures.

Methods: Pre-and postoperative serum levels of CRP and LC in 350 patients were retrospectively assessed after single level open spondylodesis (n=150) and endoscopic lumbar discectomie (n=200). Furthermore confounding variables such as overweight, ASA-classification, arterial hypertonus and perioperative antibiotics were observed to evaluate their influence on the postoperative CRP and LC kinetics. Apart from descriptive statistics, the collectives were statistically compared using multifactorial variance analysis.

Results: As expected, iatrogenic trauma had a significant effect on the maximal postoperative CRP-levels reached. Independent of the type of surgery performed, levels fell only after 2-3 days post OP. The comorbidities as well as the duration of surgery assessed had no significant influence on the kinetics of postoperative CRP-levels yet we could show that especially adipositas did play a role as to what extent postoperative CRP-levels were raised. Interestingly, the administration of antibiotics led to a slight increase of postOP CRP-values, yet serum level kinetics as such were not influenced by antibiotics.

Conclusion: For the use of blood chemistry in the perioperative observation of patients undergoing spine surgery it seems that only CRP is of any interpretational value. LC and ESR may be of interest to detect a preoperative infection but are not of much value in postoperative observation. Independent of the surgical trauma, postOP CRP values compared to preoperative base line are high for the first 2-3 days after surgery. Only after this time period can a persistingly high value be indicative for an infection. For clinical practice it therefore seems judicious to propagate CRP controls presurgically, 2 days and 5-7 days after intervention.

Clinical application of human bone marrow progenitors in spinal fusion

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Most bone substitutes are osteoconductors that lack osteoinductive properties. Therefore, these substitutes can only promote bone fusion when the bone environment at the implantation site provides these osteoinductive factors. These osteoinductive factors include the osteoblast progenitor cells. The most
abundant and readily available source is the bone marrow. Bone marrow-derived mononucleated cells including connective tissue progenitors can be concentrated rapidly from bone marrow aspirates. Concentration of cells in this way to produce an enriched autologous cancellous bone chips mixed with mononucleated cells improves graft efficacy. We began to use bone marrow progenitors intraoperatively derived from the iliac crest for augmenting spinal fusion. The purpose of this article is to describe the procedures and its clinical application. Patients who required a single-segmental pedicle screw instrumentation following placement of the paired interbody fusion cages were included, for the treatment of degenerative or spondylolytic spondylolisthesis. The surgical procedure was carried out in a routine fashion after bone marrow was obtained, with decompressive laminectomy, interbody fusion posteriorly, and pedicle screw instrumentation. Two rectangular cages were used in the interbody fusion. The chamber of cages was packed with autologous cancellous bone chips obtained during the decompressive laminectomy. Techniques for aspirating bone marrow: Bone marrow aspiration was performed before the surgery. After induction of general anesthesia, a 3-mm stab incision was made using a No. 11 blade over the superior aspect of the posterior superior iliac spine. A bone marrow aspiration needle was inserted through one penetration in the cortex. The initial trajectory was aimed roughly at the tip of the greater trochanter and the aspiration needle was advanced into the intramedullary cavity. The obturator was removed, and a syringe was attached to the needle. Drawing back the plunger created negative pressure, which caused marrow to flow into the syringe. The aspirates were collected by changing the direction and depth of the needle placement and samples were aspirated into 50-ml syringe. The first aspirate was harvested without heparin to provide a 5-ml clot of bone marrow-derived cells mixed with blood. The following five 25-ml aspirates were harvested into syringes containing 5-ml heparin solution (1000 units/ml). The heparinized aspirates was 125 ml in total volume (approximately 25-ml heparin included). Preparation of autologous cancellous bone chips plus nucleated cells including connective tissue progenitors: Samples were first subjected to a density gradient centrifugation. 20-ml heparinized bone marrow aspirates were flowed very slowly with a pipette onto a new 50-ml tube, which contained 20-ml Ficoll Hypaque solution (D=1.077 g/ml; Amersham Bioscience AB, Uppsala, Sweden). The remaining marrow aspirates (105 ml) were divided onto five 50-ml tubes in a same manner (20, 20, 20, 25 ml, respectively). Then, intraoperative centrifugation was performed at 2,500 rpm for 20 min. Theuffy coat, containing the mononucleated cells including connective tissue progenitors, was carefully collected at the Ficoll interface and washed 3 times. The clotted bone marrow from the first aspirate, which was harvested without heparin, mixed with blood was mixed with nucleated cells, and then mixed physically with autologous cancellous bone chips. This preparation took approximately 60 minutes. The authors think the concept of connective tissue progenitors is useful clinically, because any cell that can proliferate and differentiate to form the desired connective tissue such as bone or cartilage. We believe there is the potential benefit that supplementing the concentrated mononucleated cells including connective tissue progenitors enhance bone formation and speed osseous integration and recovery. ◆

Severe instability after kyphoplasty: tt options and impact on indication for kyphoplasty

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Introduction: Kyphoplasty is an increasingly popular treatment for osteoporotic vertebral fractures (OVF), based on an easy-to-learn technique and few perioperative complications. Good reimbursement and intense advertisement by the industry also play a role. PMMA-cement does not integrate into bone and there is no secondary stabilization around the cement tamp. Therefore, only primarily stable OVF should be treated with this technique. Because of the reduced bone quality in OVF, correct fracture analysis may be difficult, even with computed tomography (CT).

Methods: Analysis of 5 cases referred to our departments in 2006 and 2007. All patients had received kyphoplasty of the thoracolumbar junction or of the thoracic spine for OVF. After initial improvement in back pain, all 5 patients experienced renewed pain and immobilization within weeks, one patient suffered
neurological deficits. Presented is an analysis of the radiographic features of these fractures, how these relate to the AO fracture classification and what the implications for the primary stability of these fractures are. Based on this analysis, recommendations as to specific pitfalls when indicating OVF for kyphoplasty are made.

Results: In all 5 cases, gross instability was found around the cement tamp, in several cases with advanced destruction of neighboring vertebrae. In 1 case, subtotal spinal canal occlusion by the cement tamp had occurred. Exact analysis of the preoperative imaging studies gave either evidence to unstable burst fractures of AO-type 3.2 or 3.1, to pedicle root discontinuity or to disc-with-endplate avulsion. In all cases, this had not been recognized preoperatively. The low contrast of severely osteoporotic vertebrae in CT and inadequate slice thickness of the CT may have been contributing. 4 patients required multisegment posterior instrumentation, 1 patient died from complications of immobilization prior to the scheduled stabilization.

Discussion and Conclusion: Performing kyphoplasty in unstable OVF may cause complications that far exceed the original problem. Correct fracture analysis is therefore of paramount importance and a high-resolution, thin-slice CT scan is a prerequisite. Despite the availability of kyphoplasty, the non-operative options for treating OVF should not be forgotten.

Conceptions on spine disease in historic medicine

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In medicine as in politics, logical nexus 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.

Minimal invasive endoscopic lumbar surgery : a ten year’s experience

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Study Design: Endoscopic technique for lumbar discectomy has been used by the author since 1993. The technique is described and the results of 1562 patients are presented

Material and Methods: The goal of this operation is to reach the disc herniation in the spinal canal, using a special device with an endoscope, through a small incision. The device is composed of three tubes: one for the endoscope, one for suction and the largest one for classical surgical instruments. 1562 patients were operated on between April 1999 and December 2001. In order to permit a valid analysis of the results, a prospective study was begun. Before the operation, each patient was given a questionnaire and an explanation of what exactly was being asked. The questionnaire was to be filled out either when the patient returned to work or, if not, two months after surgery.

It is to be noted that after three months results were considered “poor” if the patient did not return to work within this period, even if he or she was able to return to work later. Prolo’s criteria were used.

Results: Of the 1562 patients, 1028 questionnaires were returned showing excellent results in 980 cases, good in 6, moderate in 1 and poor in 40. The complications observed were: discitis in 5 cases; reoccurrence in 54, of which 44 needed a second surgery; dural tear in 25; nerve root lesion in 7; and resection of articular process in 36. Of the 746 patients who were working before the operation, 706 were able to return to work with an average delay of 4 weeks. In answer to the questions on global satisfaction and on the accuracy of
the information given before surgery, 1005 responded as satisfied and 989 felt the information given to be accurate.

Conclusions: This minimally invasive technique allows a smaller incision, less trauma to lumbar muscles, better identification of the nerve root in the foramen, perfect hemostasis and no drain. Early post-operative mobilisation is easy and special wound dressing allows immediate shower and intensive reeducation. This endoscopic technique gives dramatically better results than an external approach and allows earlier resumption of professional and personal activities.

**Percutaneous endosc. discectomy via contralateral approach for distally migrated LDH**

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Introduction: Percutaneous endoscopic lumbar discectomy (PELD) has been widely used procedure. Although various techniques and approaches to herniated disc have been tried to extend the indications of PELD, distal migration with abutment on the medial wall of pedicle is not easy to approach. The purpose of this study is to introduce contralateral approaching portals to be easy of access to distally migrated lumbar disc herniation and to evaluate the clinical results.

Materials and Methods: From August 2004 to May 2007, we have experienced six cases of lumbar disc herniation which were migrated distally, that were Story 3 by the three-storied anatomical house concept and abutted on the medial wall of pedicle. Herniation of disc was occurred at L2-3 in two, at L3-4 in two, and at L4-5 in two. Five cases were approached via contralateral transforaminal route and one case via contralateral interlaminar route using 2.5mm working channel endoscope. Performing contralateral transforaminal approaches, 5mm-diametered trephine was used to enlarge the neural foramen in two cases. Preoperatively, localization of herniated disc was done by preoperative MRI and accessibility was evaluated by CT and MRI, and postoperatively CT or MRI was taken. Clinical outcomes were evaluated by the improvement of preoperative pain.

Results: In all cases, preoperative radiating pain was improved. Low back pain score was improved from 45 points preoperatively to 82 points postoperatively. Numeric rating pain scale was 2.2 against 10 preoperative reference value. There were no symptoms of exit root of approaching side in transforaminal route. In the case of contralateral interlaminar approach, mild hypesthesia was developed on the corresponding nerve root dermatome. Simple dural tear was occurred in one case.

Conclusions: Percutaneous endoscopic discectomy for distally migrated herniation with abutment on the medial wall of pedicle was successful via contralateral transforaminal or interlaminar approach without significant complications. We suggest these approaches can be one of the advanced techniques to extend the indications of PELD, and can be applied especially at the level of higher than L5-S1.

**Microdecompression of the nerve root in lumbar isthmic spondylolisthesis**

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The purpose of this report is to present the pain pathomechanisms in isthmic spondylolisthesis and clinical results of 100 patients operated by microscopic nerve root decompression.

Pain Pathomechanisms: The main source of the pain in patients with isthmic spondylolisthesis is a compression of the nerve root which is passing beneath the isthmus (exiting nerve root). The other possibility of the pain would be a nerve root sensitization by inflammatogenic materials leaked from the spondylolysis in which a degenerative arthritis is progressing. Chronic synovitis was identified in the granulation tissues histologically. Based on these two pain pathomechanisms, microsurgical decompression of exiting nerve root
roots including resection of inflammatory granulation and osteocartilaginous mass will be a useful minimally invasive technique to treat for failed patients with conservative treatments.

Indications: The patient who had following conditions was selected.
1. Main clinical symptom is related to radiculopathies.
2. Main pathology showed by neuroradiological studies is exiting nerve root compression by bony growing from the pedicle (pedicular spur).
3. Symptoms related to spinal instability are mild.
4. Over 6 months conservative therapy was not effective to improve the pain.

Methods: A 2-3 cm midline incision was enough to access the isthmus under the microscopic control. By cutting cranial edge of floating lamina with airtome, the caudal surface of lytic lesion of the pedicle was clearly identified. The pedicular spur and osteocartilagenous mass including proliferating granulation tissues were totally resected to achieve nerve root decompression.

Patients: We performed microscopic decompression in 114 patients with lumbar isthmic spondylolisthesis. We directly followed 100 patients at least 6 months (20.4 months in average). There were 20 females and 80 males. The mean age was 46.3 y.o. (16-76). Preoperative JOA score was 17.6/29 in average. Patient-base outcomes were evaluated with SF36. Spondylolysis was found at L4 in 10 and L5 in 90%. Preoperative X-ray showed no slippage in 17%, stage 1 in 65% and stage2 in 18%. “Scream canal” sign was identified in 29% and T2 high signal at isthmus in 23% on MRI studies, The form of separated isthmus observed in CT were different from person to person.

Results: Preoperative 17.6 points of JOA score was improved to 23.0 points postoperatively. Success rate was 85% according to Hirabayashi criteria. Seven of 8 lower scales in SF36 were significantly improved. The PLIF operation was added in 3 failed patients after the microdecompression.

Laser debulking versus vacuum-probe decompression: 100 cases / comparative study

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First 50 patient in group one were treated by major debulking at two or three levels. Using Endius/Zimmer non- flexible tip a mechanically strong attached to negative pressure machine with the range of 3000-6000 RPM. Second 50 patients in group two were treated by moderate or minimal debulking not to exceed two levels. I used the laser debulking techniques as well as gentler form of vacuuming and long handle hand tools. The results were better in the major debulking group. Between period of 1987 to 2007, one hundred cases of discectomy were chosen for this study. In order to qualify for this study the case has to be showing full fledge clinical as well as radiodiagnostic picture for disc protrusion. Their disc protrusion had to size beyond 2-3 mm and clinical and EMG NCS findings had to match with and be compatible with MRI findings. These cases considered to have strict criterion to be included in the study. They were chosen carefully from the pool of 1000 cases who under went disc surgery. Age and range of diagnosis were compatible in both groups all disc protrusions were in lumbar spine. Patient ages were 20 to 50 years.). In each group 90% of cases were work related. The remaining 10% were regular insurance patients.

All regular insurance patients (totaling ten cases recovered 100% with no complications. The worker compensation cases (45 in major debulking and 45 in moderate debulking) showed minimal number of complications which were drastically less in major debulking group. In major debulking group there were two facet joints syndrome; that eventually recovered. In moderate debulking group there were 4 facet joint syndrome and one with persistent disc pain that eventually had to undergo open discectomy.

Conclusion: Strict criteria for surgery still is considered to be the gold standard for assuring full success after disc surgery. Major debulking considered being the best assurance for success in worker compensation cases. Now a days it is possible to come close to full discectomy by minimally invasive techniques which avoids the negatives for open disc surgery.

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

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Background Context: Disc herniation is a common manifestation of degenerative lumbar disc disease which can causes radicular pain and focal neurologic deficits. Even though discectomy can produce symptomatic
relief in appropriately selected patients, author regard the term discectomy is something of a misnomer, in this respect author suggest the new surgical term “herniectomy”. The herniectomy mean fragment excision without extensive nucleus curettage.

Purpose: The purpose of this study is present new surgical term and evaluates the clinical outcome of percutaneous endoscopic laser assisted herniectomy for migrated disc herniations in cervical and lumbar spine.

Methods: The indications for herniectomy were neurological signs including radiculopathy, sensory changes, motor weakness and the presence of abnormal reflex due to migrated disc at a single-level, and symptoms corresponding with preoperative magnetic resonance images and computed tomography scans, unresponsive to conservative treatment for a minimum of 6 weeks. A total of 146 patients were included in the study from March 2002 to November 2003. The patients were divided into two groups (Group PECH: Percutaneous endoscopic cervical herniectomy, PELH: Percutaneous endoscopic lumbar herniectomy) according to surgical field. From March 2002 to November 2003, 30 (F:M=18:12) of patients with radiculopathy due to cervical disc herniation underwent PECH, the mean age was 43.6 years (range; 30-66 yr). From April 2002 to March 2003, 116 (F:M=43:73) of patients with radiculopathy due to migrated lumbar disc herniation underwent PELH, the mean age was 35.5 years (range; 18-65 yr). Both groups underwent percutaneous endoscopic herniectomy using a Ho: YAG laser and with forceps. The outcome instruments used were the pre operative and post operative Visual Analogue Scale (VAS), ranging from no pain (point 0) to worst pain imaginable (point 10).

Results: In both groups the improvement in the mean VAS was statically significant compared to the preoperative status. The mean period of follow up was 23.5 months (range; 17.5–28.0) in PECH group and 14.5 months (range; 9–20) in PELH group. The preoperative mean VAS of neck pain was 8.6 ± 1.7 (range; 4–10), which significantly decreased to 2.2 ± 2.4 (range; 0–8) at the final follow-up (P < 0.0001) in PECH group. The average return to work period was 9.6 days (range 1–76 days). In one patient of cervical group developed failure and underwent fusion surgery after 4 days of primary surgery.

The preoperative mean VAS of leg pain was 7.5 ± 1.7 (range; 5–9), which significantly decreased to 2.6 ± 1.8 (range; 0–3) at the final follow-up (P < 0.0001) in PELH group. The average return to work period was 14 days (range 1–48 days). During the follow-up period, there were no recurrent disc herniations and no approach related complications such as dural tearing or infection.

Conclusion: The results of this study will contribute to the establishment of surgical guidelines for PELH and PECH in the treatment of migrated disc herniation. Since the intervertebral disc consists of inner nucleus pulposus surrounded by the annulus fibrosus, the term “discectomy’ often leads the surgeon to do extensive nucleus excision induced by using the term discectomy.

Key Words: migrated disc herniation, percutaneous endoscopic spine surgery, heriectomy, Ho: YAG laser.

Selective single-level laminectomy for cervical DH: comparison to anterior dec./fusion

Experience with selective single-level laminectomy for cervical disc herniation

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In 2000, Shiraishi, et al. reported selective laminoplasty with preservation of the posterior cervical deep extensor muscles, and demonstrated that complications such as postoperative axial pain, impaired neck movement, and changes of alignment occurred less frequently than after conventional procedures. Since December 2002, we have performed selective single-level laminoplasty using the approach of Shiraishi et al. (Shiraishi’s method) in patients with monosegmental cervical disc herniation. The objective of the present study was to investigate the postoperative outcome of selective single-level laminoplasty for cervical disc herniation and compare it with that after conventional anterior decompression and fusion.

Subjects and Methods: The subjects were 15 patients undergoing selective single-level laminoplasty for mono-segmental cervical disc herniation between December 2002 and March 2005 (single-level group). Forty-five patients who underwent monosegmental anterior decompression and fusion for cervical disc herniation (ASF group) were used as a control group for comparison.
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 an 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 motion segment to be reduct in a position that is close to physiological.”

Results: The improvement rate was 63.0% for the single-level group and 62.5% for the ASF group, with no significant difference of the neurological improvement rate. As for complications, transient nerve palsy due to postoperative hematoma occurred in one patient from the single-level group. In the ASF group, dislocation of the cricoid cartilage occurred in one patient and hoarseness persisted. Postoperatively, no patient had axial pain or pain at the bone graft donor site that was severe enough to require anti-inflammatory agents. CCI and range of cervical motion were no significant differences between pre-and post-operative in either of the groups.

Conclusion: The outcome of selective single-level laminoplasty for cervical disk herniation was investigated. It was found that the neurological improvement rate was comparable with that achieved by conventional anterior decompression and fusion.

Clinical outcome and segmental range of motion in lumbar TDR: a >2-year follow up

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Object. Lumbar total disc replacement (TDR) has been regarded as a novel technology and potential alternative to spinal fusion in the treatment of degenerative disc disease by restoring and preserving the normal motion of the segment. It is essential to maintain segmental range of motion (ROM) at long-term follow-up. The purpose of this study was to report clinical outcome and compare the segmental ROM following single-level lumbar TDR.

Methods. Thirty-seven patients had single-level implantation of a TDR using Prodisc II (Spine Solutions/Synthes, West Chester, Pennsylvania), or Mobidisc (LDR medical, France), or Maverick (Medtronic, Sofamor Danek, Memphis, TN); Prodisc II (21 patients), Mobidisc (14 patients), and Maverick (2 patients). The subjects were 16 men and 21 women, with a mean age of 42 years, ranging from 27 to 56. The mean follow-up duration was 34 months, ranging from 24 months to 46 months. TDR was performed at the L4–L5 level in 20 patients and at the L5–S1 level in 17 patients. Clinical outcomes were evaluated based on the Oswestry Disability Index (ODI) and 10-point Visual Analogue Scale (VAS, 0–10) score. The segmental ROM at the operated segment was measured on flexion-extension views of plain radiographs using Cobb’s method, preoperatively, postop. 6-month, 1-year, 2-year, and last follow-up visit.

Results. Mean preoperative ODI was 68.3 ± 12.1. At postsurgery 6 months, 1 year, 2 years, and last follow-up visit, mean ODI was decreased to 19.4 ± 8.2, 15.7 ± 6.8, 17.3 ± 7.0 and 20.7 ± 8.7, respectively. The mean preoperative VAS back pain score was 8.4 (range, 7-10) and improved to 3.1 (range, 0-5) at the last follow-up visit. There were significant improvements (p<0.001) in both ODI and VAS. Mean preoperative ROM at L4-L5 was 8.1° (range, 2.1°-17.8°). At postsurgery 6 months, 1 year, 2 years, and last follow-up visit, mean ROM was increased to 13.1, 13.0, 12.5, and 11.3, respectively. Mean preoperative ROM at L5-S1 was 6.3° (range, 1.4°-13.6°). At postsurgery 6 months, 1 year, 2 years, and last follow-up visit, mean ROM was 6.5, 6.5, 6.1, and 5.9, respectively. ROM at L4-L5 increased significantly after the surgery (p<0.001), but, there was a trend of decrease of mean segmental ROM as time went by. There was no statistical difference between preoperative and postoperative mean ROMs at L5-S1.

Conclusions. Our study demonstrated marked clinical improvements after lumbar TDR. Segmental ROM at L4-L5 increased significantly after the surgery. However, there was a trend of decrease of segmental ROM as time went by, and there was no significant difference between preoperative and postoperative mean ROMs at L5-S1. The authors believe that further follow-up of this cohort of patients is needed to see if lumbar TDR has the preservation of segmental motion, which is one of the basic rationale for TDR, at long-term follow-up.

Key Words: Lumbar total disc replacement (TDR), Degenerative disc disease, Segmental range of motion (ROM)
the posterior elements, annulus 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 experience in cases with Degenerative Disc Disease 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.

Nubac® disc arthroplasty: design rationale and clinical evaluation

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Introduction: Disc arthroplasty is gaining popularity for treatment of low-back pain caused by degenerative disc disease (DDD). As total disc arthroplasty is a relative aggressive treatment with high revision risk efforts have been put into the development of less invasive methods resulting in the development of the NUBAC disc arthroplasty system. This abstract describes the design rationale and the preliminary clinical results obtained for the NUBAC.

Methods: The NUBAC is designed to mimic the natural kinematics of an intact disc and to restore or maintain the load sharing capabilities of the index disc by preserving most of the annulus, ligaments and endplates. Implant insertion is compatible to any surgical approach and minimally invasive.

The design rationale of the NUBAC has been demonstrated in a series of human cadaver studies as part of its preclinical evaluation. Aspects investigated were restoration of disc height, maintenance of segmental motion and stability, endplate fatigue strength and static-load-to-failure. A prospective multicenter study with 131 patients investigated pain and function parameters.

Results: Cadaver studies have shown that the device can restore the disc height and segmental mobility and stability to the intact state. No visible endplate or cancellous bone fractures were evident after 100,000 cycles of fatigue testing. Static-load-to-failure has shown that the failure load of the surgical repaired specimen does not decrease.

The NUBAC has been implanted in the lumbar spine of 131 patients at 135 levels from L2-S1 with more than 90% at L4/5 and L5/S1 via all three major surgical approaches: posterior, lateral and antero-lateral. Pain relief was investigated by VAS and showed good pain relief from six weeks through 2 years (VAS 78 at baseline to 30, 26, 26 and 23 at 6 weeks, 3, 6 months and 1 and 2 years, respectively). Function using the ODI showed continuous improvement at all visits (53 at baseline to 31, 26, 23, 23 and 10 at 6 weeks, 3, 6 months and 1 and 2 years, respectively).

Conclusions: Preclinical studies show that NUBAC is able to restore disc height, maintains segment mobility and stability. Clinically the pain relief and improvement of function suggest that the NUBAC is a feasible, less invasive alternative for treatment of low back pain caused by DDD.

Percutaneous lumbar fusions: indications and pitfalls

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Historical background: We carried out this technique for the following reasons: after failure of percutaneous iliac graft under general anesthesia. We performed this technique on five patients after A. Monteiro† in 1989 and H.J. Leu; after improvement of endoscopic tools.

Material and methods: Since the end of 2004, we operated on 35 patients using this technique, mean 55.6 years old (34 to 90 years), 13 men and 22 women; 40 operated levels: 2 L1L2, 5 L2L3, 7 L3L4, 19 L4L5, 7 L5S1. Cages without associated plates: 27 patients. Europa cages and WSH plates: 8 patients.

Etiology: 4 degenerative spondylolisthesis; 20 sequellas of previous operations: 15 for discal hernias, 4 on discopathy adjacent to an arthrodesis, 1 on foraminal osteoarthritic stenosis L5S1; 11 severe degenerative discopathies: 1 on transitional abnormality; 2 on osteoarthritic stenosis; 8 primitive.

Technique: - local anesthesia and sedation, radiolucent table - mean duration: 50mn if isolated cages, 120mn if associated plates. - Blood loss < 100cc. Europa Cages®, will be filled up with osseous spongious
grafts or bone substitute or rh-BMP2. Cannulated screws and WSH® plates present a big side and a small side, where the height is two millimeters less.

Immediate results: Initial pains disappeared immediately for all 36 patients. We had minor complications: -1 radicular irritation on the initially intact side without malposition of cage nor screw, with temporary paresia of foot elevators; -1 aggravation of pre-operative paresia of foot elevators without recovery after 10 months, on a multi-operated patient. Immediate post-operative imaging (standard & CT-scan) showed; 1- good cage positioning 37 times on 40 levels operated on. One cage was too small on one level and after 7 weeks. Two cages in a limit positioning displaced themselves laterally on an abnormally convex vertebral end-plate and were reoperated on after 2 weeks by an open arthrodesis. 2- wide opening of the foramens 3- the good positioning of the 32 pedicular implants on the 8 patients who received plates, except for 2 where they compressed a nerve root, followed by a paresia of foot elevators. They were changed after a few days by the same percutaneous technique.

Secondary complications Secondly, we count amongst the secondary complications: - 4 secondary migrations of cages without plates, with a follow-up of 8 to 14 months; - 3 reoperated cages by the same percutaneous technique, forward "re-impaction" of the cages, and by completing with percutaneous WSH plates.

Finally, 35 patients with a follow-up of 1 to 36 months had 8 percutaneous reoperations, and 3 open surgeries. We had not any hematoma, nor infection, nor thromboembolism, nor cauda equina syndrome.

Global results: The result, with a mean follow-up of 11 months (median 11 months), is very good or excellent for 28 patients, good for 3 other patients, fair for 3, and we regret 1 failure. The mean VAS was from 6.4 to 3.1.

Our present indications:
- Intractable lombosciaticas with narrowing of the intervertebral and foraminal space, after failure of endoscopical or open techniques
- Formal indication for lumbar arthrodesis on a patient for whom a general anesthesia with open surgery is contra-indicated.

Our contra-indications: osteoporosis, pusillanimous patient, frank motor deficit.

Conclusions: The difficulty to spread this type of surgery is the absence of education given to surgeons about percutaneous endoscopical surgery; further studies will be able to assess it, as shown by present trends claimed by all patients.◆

**Less invasive lumbar spine fusion: a comparison study**

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

In the prospective comparison study 2 groups were compared: Group I, percutaneous fusion, and group II a traditional medial approach to the lumbar spine. In all two groups monosegmental or bisegmental fusions in the lumbar spine were performed. From January 2005 to September 2007, 147 patients with osteochondrosis, spondylolisthesis and failed back surgery syndrom were operated. In all cases fusion with autogenic or allogenic bone graft was performed. In group I the mean age at operation was 48 years (range from 35 to 63), 72 patients (39 women, 33 men); and in group II the mean age at operation was 39 (35-73), 75 patients (43 women, 32 female). For the clinical examination VAS, a patient satisfaction score and a SF 36 were used. A monosegmental fusion was performed in group I in 60 cases and in group II in 45 cases. A bisegmental fusion was done in group I in 12 cases and in group II in 30 cases in the lumbar spine.

The mean follow up was 18 months (range from 3 months to 34 months). The mean time of operation was in group I 65 minutes (55 to 125); blood loss was in mean 25 ml (10 to 150), skin incision 4.5 cm (4 to 8cm). In group II mean time of operation 75 minutes (50 -120), blood loss 600 ml (350-600), and skin incision 12 cm (9-15). There was no statistical significant difference between the both groups in VAS, SF 36, and patient satisfaction score after 1 year follow-up. There was none infection, none neurological complication. In group I in two cases a revision surgery was necessary in cause of medial misplacement of the pedicle screw. No broken rod or broken screw was seen. The fusion rate was 85% in both groups.
The preliminary results have shown that percutaneous pedicle screw instrumentation is a reliable technique and has advantages comparing traditional open procedure. However, more prospective comparison study of a open and minimal percutaneous procedure with long time follow up are necessary.

**Percutaneous anterior lumbar stabilization**

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The spinal instability represents a specific state of a structure in which an addition of small load results in an excessively large displacement in an unpredictable or erratic manner. In contrast, an abnormally large, but in the right manner, segmental motion can be defined by the term “hypermobility”. Spinal instability can be found in various conditions, such as after trauma or excessive surgical removal of supporting structures or advanced degenerative conditions or malformations. A very good anamnestic investigation of the patient must be made.

Dynamic flexion/extension and lateral bend can show the abnormal spine motion. Plain radiographic findings, that suggest segmental instability, include disc space narrowing, osteophytes, spondylo-deformities and spondylolisthesis. Spinal fusion has been a commonly accepted procedure in spine surgery. The posterior approach (P.L.I.F.) is carried out by the removal of the posterior part of the lumbar vertebra. Disadvantages of the posterior lumbar interbody fusion include the possibility of extrusion of the graft, secondary spinal instability, dural tears and scarring of the anterior portion of the dural sac. The anterior approach (A.L.I.F.) may be carried out transperitoneally or retroperitoneally. Disadvantages of anterior lumbar interbody fusion include the risk of abdominal adhesions and incisional hernias, particularly in the transperitoneal approach; in males also carries the risk of impotence or retrograde ejaculation.

By percutaneous lumbar posterolateral and parapedicular approach it is possible to stabilize the lumbar spine using cages (B-Twin) and calcium phosphate bone graft substitute (pure beta-tricalcium phosphate), when stand alone solution is indicated.

With this minimally invasive spinal technique the trauma for the patient in the surgical area is minimised and consequently complications are very uncommon.

In our experience, if an interbody fusion is being considered, we have found percutaneous interbody fusion to be easy technique, more reliable, and associated with fewer complications than open traditional approaches.

This study was carried out from October 2002 to February 2007. In our follow-up we had a success rate was more than ninety percent. In this study period there were neither incidents during surgery, nor significant complications following these operations. Average time to perform a standard lumbar fusion by this procedure was about 60 minutes. Comprehensive training in this kind of surgery is necessary before performing operations. We think that continued development and improvement of instruments, longer follow-up periods and a greater number of patients treated by this technique, will further confirm this percutaneous surgical approach.

**Minimal invasive stabilisation of lumbar degenerative spine**

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Operative interventions directed to achieve fusion in degenerative spinal diseases are as always popular among the spinal surgeons. Many of them are seeking to achieve fusion by way of mini-invasive method, thus suggesting minimal traumatization for the spinal segments tissues including the vertebral canal spinal elements. The purpose of this report is reflecting authors experience when applying mini-invasive fusion in different clinical variants of degenerative diseases of the lumbar spine. Mini-invasive interbody spondylodesis using ceramic implants and B-twin systems are performed in 42 patients; hernias of the intervertebral disks L4-5 (27) and L5-S1 (15); percutaneous arthrodesis (fusion) of the facet joints was made for spondyloarthrosis in 16 patients. Ceramic implants were applied in 30 patients and B-twin system – in 12. When being assessed by Oswestry scale good results were obtained in 20 patients, satisfactory results – in
8 patients, and in 2 patients repeated operative intervention was demanded. Among 12 patients in which B-twin systems were applied there were 10 patients with good results and 2 patients with satisfactory ones. 10 patients with arthrodesis of the facet joints had good results, 3 patients – satisfactory, and 3 patients – insatisfactory.

Conclusion: Application of mini-invasive surgical techniques to perform fusion is considered to be a promising direction especially for interbody fusion. However, additional internal or external stabilization by means of transpedicular constructions can give more reliable formation of the bone bloc.

Success enhancement in minimally invasive fusion: bioactive instrumentation surface

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Less invasive, tissue sparing fusion techniques have some inherent limitations that can effect a successful arthrodesis. Because of the constraints of the approach, there is often a smaller area for the application of bone graft, difficulty with debridement, a of graft material and less soft tissue bleeding to supply important inflammatory cells and factors.

Attempts to enhance the success of these minimally invasive techniques have included the use of graft expanders, bone growth factors, precursor cells and bioactive coatings on necessary implants. After evaluating several of these strategies we have begun studying how bioactive surfaces can influence the adherence of these implants to bone and promote surrounding bone growth.

Submerged electro-spark deposition is a technique that directly welds ions into the surface of a metal. We tested the success of electro-spark deposition of calcium and phosphorus on modified reconstruction plates in the rabbit radial defect model.

Two groups of 8 eight rabbits were studied. In the control group, Ti-6AL-4V titanium cranial 4-hole reconstruction plates (Synthes, Inc.) were used to span a 5 mm radial defect. In the experimental group, the reconstruction plates were treated with electro-spark deposition of calcium and phosphorus. The ion concentrations used were based on prior work studying cultured osteoblasts. At four weeks, radiomorphometry and histomorphometry analysis was performed to assess defect healing.

Percent radiopacity, as measured by radiomorphometry, was 68.9±4.9% in the control group and 85.0±7.3% in the treated group. In addition, the percent of new bone growth filling the 5 mm radial defect as measured by histomorphometry was 46.2±6.8% for the control group and 65.1±9.1% in the treated group. Both outcome measures were significant at the p<0.001 level.

These results demonstrate that welding of calcium and phosphorus into the surfaces of surgical implants may have a significant effect on bone healing. The defects healed faster and with significantly more bone when the implants were treated. Future studies will evaluate the utility of electro-spark deposition modified implants for interbody fusion.

Technologies of cage implantation for posterior interbody spine stabilization

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PLIF and TLIF find broad use in restabilisation of the vertebral column due to its degenerative instability. In this report we shall look at the questions of reducing invasive implantation technique of trapezoid cage through inter-arch space with medial facetectomy.

In our universities morphometric X-ray and biomechanical research of PLIF were carried out with the aim of designing a minimal invasive technique.

Geometric studies on inter-arch space and its relationship with the cage, interbody space, nerve root. The parameters of the cage for implantation are determined by the sizes and forms of the inter-vertebral space. During PLIF one of the important determinants for implantation is mounting the cage through the vertebral canal with minimal trauma to the spinal structures. The Medial and lateral walls of the canal for implantation are: nerve root protected by retractor and the medial part of the facet joint. During the carrying out of PLIF the area of interarch space should not be less than 250 – 300 mm2 with a cross-section size...
minimum between 18 – 20 mm2. The width of the cage should be within the ranges of 10 – 12 mm2. In such a relation the nerve root undergoes minimal stress and deformation and the facet joint maintains the congruence of involving articular surfaces during facetectomy. In this case the proportion between the cage width and inter-arch space is optimal at 1.6 or near this figure. By reducing this proportion to 1.2 – 1.3, the cage implantation becomes traumatic to the spinal structure (stress and deformation of the nerve root), however increasing the proportion to a coefficient of 2 or more improves the possibility of implantation but will cause an appreciable resection of the facet joint. In this situation it is prudent to switch to the TLIF.

Conclusion:
During the planning of minimal invasive PLIF technique it is important to take into consideration the form of the interbody space, inter-arch space, interbody cage, nerve root and their interactions and proportions.

**Transaxial fixation of the lumbosacral segment as a stand-alone procedure**

Preliminary results with 1 ½ years follow-up

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Introduction: Discectomy and fusion has a long standing history as a treatment option for invalidating chronic discogenic back pain. Standard procedures include anterior and posterior lumbar interbody fusion (ALIF and PLIF), whether or not combined with pedicle screw fixation. All of these procedures are invasive with potential damage of muscles, facet joints, nerve roots, scar formation etc. The transaxial approach (AxiaLIF™) is a novel minimal invasive way of gaining access to the L5/S1 disc space with the possibility to remove disc, clear endplates, fill it with a graft and achieve fusion.

**Aim of the study:** To establish whether transaxial fixation as a stand alone procedure can achieve the same results as standard approaches in patients with single level discopathy at the lumbosacral joint.

**Material and Methods:** Since March 2006 50 patients were treated for discogenic back pain. There were 19 male and 31 females with an average age of 41.6. All patients had discopathy of only the lumbosacral segment. Five patients had had previous disc surgery. Pre-operative work up included plain films, MRI, discography (provocation and anesthetizing), VAS, Oswestry Disability Index (ODI) and SF-36 scores, demographic features. Fixation was achieved by the transaxial presacral approach, filling the disc space after removal with osteogenic bone matrix substitute. Average operating time was 44 minutes. Patients were discharged after one or two days, there was no specific post-operative treatment.

**Results:** Of the 50 patients 21 were followed up for at least one year. Complications include one haematoma discharge from the wound, one case of halo around the rod only in L5 and two cases of minimal subsidence. All of these patients were without complaints. Average VAS scores dropped from 7.7 pre-operative to 3.8 after 6 weeks and 2.8 after one year. For ODI the scores were: 43, 25 and 13. In 17 (81%) of the patients with at least one year follow up an improvement of 25 points or more on the ODI was noted. All but one patient showed clear signs of fusion on one year post-operative CT-scan. Some patients showed very early signs of fusion, even at 6 or 8 weeks.

**Discussion:** Transaxial fixation is a minimal invasive approach that bypasses many of the known disadvantages of fusion procedures. In this limited study it can be seen that the stand alone fixation is feasible, safe and effective, at least with this limited follow up. Once fusion is achieved problems due to the type of fixation as such are not expected.

**Conclusion:** Transaxial fixation of the lumbosacral segment is a safe, effective and least invasive procedure in which results at least similar to traditional approaches can be achieved. More patients and longer follow-up studies are however required.

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**Re-stabilization in ddd with the isolock device**

Dynamic restabilization of degenerative lumbar instability: updated midterm results

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Introduction: Between competing posterior (PLIF) and anterior (ALIF) fusion techniques and non-fusion techniques (disc replacement) in lumbar spine disorders, semi rigid stabilization techniques became more and more important.
Material and Method: The IsolockR device contains top-loading pedicular screws, which are connected with special semi rigid plates, which have one or two “semi-rigid” joints. These plates are laid between eccentric hemispheric washers, which guarantee another semi rigid element. The IsobarR device has “less rigid” bars loaded into the top open screws. Since March 2003 the IsolockR device (in more recent time both systems) have been used in 154 patients. In 37 cases PLIF technique (PROSPACE) were added, in 9 cases TLIF (TRAVIOS). To 84 patients, who have more than 36 months after surgery (operated on in 2003 and 2004), a questionnaire was sent to evaluate clinical results (back to work, pain level, pain killers, VAS, satisfaction with the clinical result). 43 patients sent it back. Most of them (17) were in the age group 51-60 years; the youngest patient was 26 years of age, altogether 4 patients in the group 30 years or younger. There is no evident difference in the patient’s sex. (20 females and 23 males). 14 patients, who had surgery in 2003, have a follow-up more than 48 months, 25 patients, who had surgery in 2004 have a follow-up more than 36 months. Clinical results of these patients were evaluated by a questionnaire. Radiographic controls have been carried out the third and fourth year after surgery. The patients can be categorized into 4 indicative groups: 1. Lytic spondylolisthesis with intact disc, 2. Degenerative deformities and spondylolisthesis, 3. Disc degeneration combined with instability of the adjacent segment, 4. Instability of the adjacent segment after previous surgery. The results of a group of 43 patients, who underwent surgery 36-46 months ago, are presented (23 males, 20 females). 6 patients were younger 30 years, 4 patients older than 60. Most patients were in the group 51-60 years of age (17). Back to work: 40% males and only 18% females, operated on in 2003, 44% males and females from 2004. 70% of males use painkillers, 70% of females. Pain level decreased in 6 patients (14%) under 10% of previous, in 11 patients (26%) down to one forth, in 14 patients (33%) to approximately half, 6 patients (14%) to three fourth, 5 patient have had any pain, 1 patient pain without change of intensity. 91% of females and 79% of males enjoyed with the results after surgery. In 7 patients (13%) revision surgery followed.

Complications: One deep infection occurred, which healed after irrigation therapy without metal removal. In two patients with PLIF procedure a dura leak occurred. Root irritation after PLIF procedure we noted in 3 patients. Conclusion: To obtain objective results after lumbar spine surgery is not very auspiciously. Pain scores are individually affected and related to the patient’s social status. Fluoroscopically results and pain descent in our semi rigid stabilized patients seem very encouraging.◆

Biomechanical analysis of dynamic stabilization in degenerative lumbar deformities

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Introduction: After treatment of degenerative lumbar deformities using instrumented fusion, complications occur including infections, adjacent segment disease, pseudarthrosis, and screw-loosening [1]. By avoiding donor site morbidity, conserving the anatomy and reducing stresses in the bone-screw-interface, dynamic stabilisation (DS) procedures may reduce those complications. This study investigated the potential use of posterior DS-implants for the treatment of degenerative lumbar deformities.

Methods: Parameters obtained from x-rays of 12 patients and from literature were used to generate two FE-models: A) spondylolisthesis (3mm), B) lateral tilt (5°) combined with axial rotation (4°). The models were moved under displacement control into a normal position and implanted with a DS-device or a rigid fixator to hold this position in equilibrium, thereby mimicking surgical reduction of the deformity. The resulting implant forces and deformations were analyzed.

Results: The dynamic and the rigid implant maintained the reduction of the spondylolisthesis to 46% and 76%, the lateral tilt to 80% and 92% and the axial rotation to 33% and 70% respectively. For case A) the shear forces in the rigid construct were less than 10 fold of those in the DS-device. For case B) the rigid device showed shear forces up to 7 times greater than the dynamic device.

Discussion: In the axial direction the DS-implant reduced deformities similarly to the rigid device. Its capacity to restore rotational deformities seems less pronounced. Lower grade spondylolisthesis can be treated to a certain degree, confirming clinical results [1].

The loads in the DS-device were lower compared to the fixator, indicating lower stresses within the bone-screw-interface [2]. These results suggest that DS-devices may reduce structural deformities and may be an alternative to rigid instrumentation.

1. Cho
2. Schnake
3. Seebeck ◆
Lumbar dynamic restabilization of the posterior elements: interspinous "bracing"

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The role of the posterior elements in lumbar pathology and stability has been widely recognized after their role has been "re-discovered" in recent years. Through an increase in less invasive surgical approach options in the treatment of spinal stenosis at the lumbar level, the use of interspinous "bracing" has increased considerably from its origins by means of ligamentoplasty. Several devices and implants are now available and have been recently introduced. From all these three different overall concepts or indications can be identified: a). rigid distraction, b). soft distraction and c). distraction-restabilization after decompression.

Clear cut indication criteria are mandatory in order to use the right implant for the pathology to be addressed. We will report in detail on our experience using the Coflex interspinous implant.

An initial series of 100 patients operated for spinal canal stenosis using a microsurgical mini exposure has been followed now for 27 months. Our patient collective had an average age of 62.8 years with an homogenous distribution of male-female patients. The primarily involved segment as expected was the L4/5 level followed by L3/4.

The VAS score dropped to 4.1 from a pre-op mean of 8.0 at 12 months and maintained itself stable in those cases were structural problems, such as scoliosis, were not associated. The Oswestry scale improved from 54% pre-op to 40% also at the 12 month control. At 24 months there was a slight worsening of 2%.

All but 2 patients were satisfied with the outcome of surgery. Indication criteria, technical aspects, pitfalls and possible considerations for ongoing developments will be presented for discussion. (A workshop is scheduled).

Interspinous X-stop® device in lateralis stenosis in older patients: Pisa’s experience

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Our experience using X-Stop device, interspinous process distraction system made of high strength titanium and peak, started in 2006, in elder patients with foraminal stenosis (over 65). It is about the first 30 patients treated (18 male, 12 female) with persistent sciatica or cruralgia initial claudicatio, sometimes degenerative spondylolisthesis grade 1 (preoperative Vas score average 8, Oswestry Score average 58% → severe disability). Surgical technique is fast, with a small surgical exposure; sometimes is made with local anaesthetic associed to a sedative (8 patients). In first postoperative day patients may sit on the bed and start kinesis of the legs (active–passive). In second postoperative day they can walk with lumbar corset that must be used for three weeks. Patients showed excellent results with a significant reduction of the pain (postoperative Vas average 2) and of disability (Oswestry score average 28%).

Some patients have manifested a return of symptomatology perhaps caused by an early start of usual activities because of excessive confidence in their recovery capacities due to a reduction of pain. Short-term results, in the contest of limits fixed by a strict indication, are very encouraging. Indications are: old patients, low functional requires, comorbidities that limit major surgery.

We think that this technique is not indicated in patients younger than 65 years old, with high functional demands, with important instability or central stenosis, degenerative spondylolisthesis more than grade 2° or severe osteoporosis.

Diam® technique in lumbar spine surgery

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When lumbar disc herniations have to be surgically treated, we usually carry out two types of operations:
1. Minimal invasive interference with an anterior lateral extraperitoneal minimal approach. We have developed this method in our clinic and we have been using it since 1991. An operation lasts for 60-90 minutes and an average blood loss is 50 ml.

2. Microscopical discectomy with a posterior interlaminar approach. The type of operation is performed if discs L4-5 – L5-6 have a low location relative to the wing of ilium, the height of the disc is less than 10 mm, if the disc is sequestrated and the sequestrum is 1/3 or more of the height of the vertebral body.

In order to stabilize the spine, the DIAM spinal stabilization system has been applied for the last two years.

Indications for the DIAM system:
1. Operations at a level of one disc (due to supermotility resulting from the operation).
2. Operations at a level of one disc if there are signs of pathological motility of vertebral bodies and an excessive load acting on intervertebral discs and facet joints.
3. Operations at a level of one disc if the spinal canal is narrow.
4. Operations at the level of the disc L5-1 with fixation at the level of L4-5 if there is a disc herniation and supermotility of the bodies L4-5.
5. Multilevel instability without interference on discs.

The DIAM implant procedure takes 10-15 minutes. However it involves a number of factors that shall be taken into consideration. If an interspinous space is narrow, the interspinous joint shall be removed very carefully. Damage to the bone should be avoided. One shall be very careful when separating spinous processes with a distractor to obtain sufficient space between the spinous processes and not to break them. When defining the size of the required implant, the space for a measuring instrument shall be considered. If it is impossible to enhance the space, e.g. measuring instrument No 12 is hardly inserted, implant No 10 shall be inserted. In our experience the implant will be well fastened. All cases have shown an increase in the interspinous space and decrease in pathological movement between the vertebral bodies. Clinical assessment of the results of the operations using the DIAM system has proved an increase in stability of the spine, disappearance or significant decrease in pain syndrome.

Tt of degenerative lumbar affections with interspinous device Coflex® first experience

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Objective: To evaluate the usefulness of the DIAM (dynamic interspinous amortization device) device in patients affected by low back pain (LBP) due to degenerative disc disease (DDD). Prospective non controlled case series.

Background: Recently a number of interspinous devices for dynamic interspinous distraction-stabilization have entered the clinical practice in Europe. All of these devices have a common property of acting on the posterior part of the functional spinal unit by distracting the spinous processes and avoiding extension of the treated segment. Consequently, these systems seem to improve the cross-sectional area of the thecal sac and enlarge the diameter of the intervertebral foramina. What was found as a collateral observation after implantation of these devices was that those patients affected by degenerative disc disease and low back pain, improved significantly in their pain level.

Methods and Materials: From November 2002 till December 2006, 316 patients underwent surgery for a total of 403 DIAM devices implanted. Fifty-two consecutive patients, mean age 49.4 y (± 12.4), affected by LBP due to DDD were included in the study. There were 29 females and 23 males, aged between 29 and 77 years (mean 49.4 ± s.d.12.4). The pre-operative symptom duration ranged from 6 to 84 months (mean 31.8 ± s.d.20.2, median 24 months). The following diagnostic measures were performed in each patient: MRI, dynamic x-rays and provocative discography positive for pain reproduction.

The patients were followed for pain by VAS and for functional status by self-reported Roland-Morris Disability Questionnaire. The minimum follow-up was 24 months (24 to 36). The intermediate follow-up at six, twelve and eighteen months was tested for, too.

Results: To determine the number of improved patients we have arbitrarily selected a cut-off criteria based on a 50% of improvement as calculated on the VAS scale comparing the 24 months VAS values to the VAS baseline values. Forty-two patients reported an improvement superior to 50%. Four patients had an improvement of less then 25% and 6 patients showed an improvement between 25 and 50%. Including all of the patients, the values for the VAS at time 0 was 6.6 improving to 1.3 on 24 months. The mean functional status at time 0 was 12.8 improving to 3.5 at 24 months. The Overall patient satisfaction with the treatment was 72.6% at 24 months. No long-term complications were observed.

Conclusions: This preliminary report indicates that the DIAM device could possibly be useful in the treatment of LBP due to DDD. Further research with RCT is necessary to confirm these preliminary results.
Treatement of degenerative lumbar affections with interspinous device Coflex® first experience

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Introduction: The dynamic interspinous stabilization device (Coflex) was designed by Jacques Samani in 1994 to provide non-rigid fixation, and to treat different conditions affecting the degenerative diseases of the lumbar spine. Rigid posterior instrumentation can lead to facet arthropathy and adjacent level degeneration in the long-term. The use of the device coflex is less invasive strategy that provides a balance between safety and effectiveness.

Materials and methods: Dynamic interspinous fixation was performed in 37 patients at the age of 21 to 64 years. Mean follow-up was 1 year 2 months. 33 patients underwent surgery for the first time and 4 had recurrent herniated disc.

The total number of implants used on the 37 patients was 39. Implant sites were as follows: L2 L3 – 1, L3 L4 – 5, L4 L5 – 27, L5 S1 – 4; 35 implants were at one level, 2 implants at two levels. The implanting technique is simple. Using a conventional median approach, the spinous processes are sparingly resected either side of the ligamentum flavum; endocanal procedure is performed: decompression, release of the foramen, possible curettage of herniated intervertebral disc. The size is chosen using templates. Coflex is then inserted. The clips are tightened around the spinous processes.

Indications:
- degenerative lumbar spinal stenosis (DLSS) - 11 patients;
- isolated herniated disk – 14 patients;
- lumbar spinal stenosis with herniated intervertebral disc – 6 patients;
- herniated disc + vertebral instability - 2 patients;
- recurrent herniated disc - 4 patients

This technique shouldn’t be used in severe lumbar spinal stenosis for which complete laminectomy is sometimes preferable to simple decompression. The sacral spinous process in some cases does not provide good support, but we need to mark in preoperational period the quality of the sacral spinous process. The best indication is a single “Coflex” preferably positioned at L4 L5. The ODI and VAS for lower leg pain and low back pain scores were used.

Results: Mean values of the Oswestry Disability Index and VAS in patients examined at 6 and 9 month postoperatively decreased up to the level of minimal lesion. We had no late neurological complications related to the “Coflex”, and no cases of the device penetration inside the canal. Radiological signs of bone tissue resorption in bone-implant interface were not observed.

Conclusion: The major indication is a single “Coflex” positioned at L4-L5 to treat instability, lumbar spinal stenosis, large and recurrent disc herniation.

Tt of degenerative lumbar affections with interspinous device Coflex® first experience

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An interspinous dynamic stabilization device like COFLEX is a titanium surgical implant intended for use in patients with radiographically confirmed moderate to severe spinal stenosis and/or minimal to moderate segmental instability. The device is specifically designed to provide stabilization without fusion that is by restricting mobility of the vertebral level, but not completely. It reduces stress at the posterior joints partially modifying lordosis. It is limited to use in one or two levels from L 1 to L 5. Furthermore COFLEX can be used in cases of recurrent disc herniation accompanied by hypermobility. It can also be used as an adjunctive therapy to stabilize an adjacent stable fusion. As to cases of erosive osteochondrosis, probably accompanied by spinal stenosis, there aren’t sufficient experiences yet. In our department the interspinous dynamic stabilization technique has been in use for two years. Since January 2006 we have operated on 34 cases of erosive osteochondrosis using COFLEX. We had 18 female and 16 male patients, aged from 39 to 80 years (average age 59 years). Levels of surgery included: L 4/5 (28 x) L 3/4 (6 x). The 1 year follow up has shown...
in 83 % an excellent improvement of severe back pain and neurological symptoms. The remaining 17 %
have shown remarkable improvement. We have had no major complications. Long term results will be
followed up. The implant offers a relatively easy surgical treatment and is a less invasive tissue–sparing
technique. To sum up we can say that the erosive osteochondrosis with / without spinal stenosis has proven
to be a good indication for an interspinous dynamic COFLEX stabilization. Of course, additional microsurgical
decompression must be applied whenever necessary. 

**New percutaneous l.a. device for lumbar spinal stenosis - 25 cases using Superion®**

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Introduction: Lumbar spinal stenosis is one of the more frequent condition seen in any orthopedic or
neurosurgical practice. Symptoms usually consist of back, buttock, and/ or leg pain, with lower-limb sensory
and motor deficits. Patients with lumbar spinal stenosis usually report difficulty in walking long distances as
they were able to do before the stenosis. Surgical treatment is usually performed in patients with moderate to
severe limitation and comprises of decompression of the neural canal and nerves. However open surgery
has several negative consequences. It is done under general anesthesia and there is a risk for dural tear
during the operation and also fibrosis and adhesions in the long run.

Purpose: Our short-term experience of first 25 cases with a new device (Superion Interspinous Spacer) which
is inserted percutaneously, under local anesthesia to decompress the stenotic level is reported.

Materials and Methods: From July 2007 onwards, our first 25 cases with up to 2 level stenosis who
underwent implantation of the Superion Interspinous Spacer under local anesthesia in the angiography room
are reported. Only patients who were symptomatic in extension and their pain was relived in bending forward
and who had also stenosis in the CT scan up to 2 levels underwent implantation of the device. The VAS was
recorded before and after the procedure. The procedure is performed under local anesthesia in the
angiography room under image intensifier. A 1 cm cut is performed in the midline and a 8 mm cannula is
inserted splitting the supraspinous ligament and between the spinous processes of the treated level.
Fluoroscopy is taken to verify the exact depth of the cannula. The device is inserted through the cannula in a
closed position and opened between the spinous processes while performing caudal and cephalad directions
to view that the device sits well on the spinous process of the above and below vertebra. A continuous
fluoroscopy is done also on the lateral projection to view the opening of the canal.

Results: our series comprises of 24 patients (11 males and 13 females) with 25 implants. Mean age 70.4
years (48-85 years). Average surgical time 23 minutes per level (last two cases 18 minutes per level). Local
anesthesia and mild sedation was used. No intra-operative or post-operative complications were reported
and all patients reported improvement of their symptoms.  The VAS was improved from 6.2 points to 2.8
points on average.

Conclusions: The Superion Interspinous Spacer is ideal solution for patients with moderate symptoms of
spinal stenosis as an alternative to non-surgical management or invasive surgical treatment such as
laminection. The surgical technique is simple, it is done under local anesthesia, there is less tissue
dissection, and less potential for complications and very efficous for moderate spinal stenosis patients. 

**Aperius® PercLID: Indication, surgical technique and preliminary results**

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Interspinous spacer devices have been recently used for cases of lumbar stenosis and spinal claudication. In vitro
studies have demonstrated a reduction in facet joint forces by 68% and annulus pressures by 63%. MRI studies
have demonstrated increased canal and neural foraminal area after implantation of these devices. Previous
studies by Zucherman et al. and Siddiqui et al. have demonstrated patient satisfaction rates of 71-73 %.
Vertebroplasty is now an effective, minimally invasive method for the treatment of less complicated pathological spinal fractures at a bony rarefaction or oncology. In some technologies vertebroplasty is used as an auxiliary method of strengthening of vertebra for subsequent, more reliable fixing of internal metal designs. Often, batch quantity of cement introduced into the bone tissue of the vertebra is determined empirically, depending on the personal experience of the surgeon. The “Pozvonok” program, applied mathematical program was created in order to introduce a coherent method to determine the exact batch quantity of bone cement introduced into the vertebra. The program has a convenient and simple interface that allows preoperative planning and calculation of the volume of cement in each individual case to within 0,05 ml. The program gives a result in the form of a number in any standard measuring system. The surgeon considers geometric parameters of the injured vertebra (height, radius of the basis, the size of the cross-section, etc.) measured on roentgenograms. Successful application of preoperative planning of vertebroplasty in 4 patients with compression fracture vertebra due to metastasises was applied. Two cases were thoracic applications, and two cases were in the lumbar region. Vertebroplasty was performed under local anesthesia percutaneous, trancpedicular from two sides introducing opaque “Simplex” cement by Stryker with the addition of barium (1:10 to parts of dry cement). For the preparation and introduction of cement we used trocars and the PCD Stryker systems. During the operation, monitoring of cardiovascular and respiratory systems is obligatory. In the postoperative period, treatment of accompanying diseases is performed, if necessary. Activation of patients was performed on the first day after operation. In some cases facilitated orthesis was applied which is not obligatory. An estimation of pain in a backbone during the postoperative period showed a mean score of 0.1 point indicating “discomfort”. In all cases, the use of this method for hardening and correction of the broken vertebra, restoration of functionality of the spinal column and “quality of life” results were optimized in both the early and remote stages after the procedure. Complications from cement leakage, and other complications from the vertebroplasty were not observed.

Conclusions:

• Application of the programmed preoperative planning vertebroplasty allows precise calculation of the volume of applied cement and reduces the probability of complications from the procedure.
• Application of mathematical planning for vertebroplasty demands further studying and perfection.

Vertebroplasty in vertebra plana - feasibility and indication

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Vertebra plana is thought of as a contraindication for vertebroplasty, especially when the posterior wall is fractured or even propulsed into the spinal canal. On the other hand, in many cases there is the need for intervention in persisting painful condition without neurologic impairment.
Method: We report a case series of 5 patients presented to our clinic with painful vertebra plana. In all of the cases, the distance between upper and lower endplate at the center of the vertebral body was less than 5 mm. The posterior wall was involved in all of the patients. Fragment protrusion of more than 2 mm was found in 3 patients. The sagittal index SI was 0.3 and the bisegmental kyphosis angle was 15°. In all of the patients, MRI showed a vertebral edema in T2 weighted image. In 2 patients, a central void filled with hematoma was demonstrated. In 2 patients, flexion/extension X rays in lateral decubital position revealed a pseudarthrosis with vacuum phenomenon inside the vertebral body.

All of the patients underwent vertebroplasty after closed reduction. Therefore, the patient was placed in prone position on the operating table. Under general anaesthesia, axial pull between pelvis and shoulders was applied and by manual pressure onto the apex, kyphosis was reduced. Then, bilateral transpedicular trocars were placed inside the vertebral body. The intraosseus position was demonstrated by saline injection and visible communication between the trocars. The vertebroplasty cement (Spineplex, Stryker, USA) was prepared and waited for polymerisation until the “stabile drop” stage. Then the vertebral body was filled under fluoroscopic sight.

Results: Filling was possible in all of the patients. Cement extrusion into the adjacent discs appeared in 3 of 5 cases. A reduction of the kyphosis was possible in 3 patients. Sagittal Index increased to 0.5, bisegmental kyphosis was reduced to 10° on average. No vascular or neurologic complications were seen. All of the patients reported an immediate reduction of pain on the day following surgery. Average VAS was 8 before and 3 after surgery.

Conclusion: Vertebroplasty also in painful vertebra plana is an efficient and safely feasible intervention in the hands of experienced surgeons.

Anterolateral percutaneous vertebroplasty at C2 for metastasis & facet joint block 

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Percutaneous vertebroplasty (PVP) of the axis is less aggressive than any surgical stabilizing procedure performed in the upper cervical spine and does not restrict the mobility of the upper cervical joints. The disruption of the weight bearing unit of the second cervical (C2) vertebral body causes excessive load at the relatively small adjacent upper cervical joints. Upper cervical joint injections before or after PVP at the C2 level have not been reported.

A 67-year-old male was referred to the pain clinic with a 6-month history of increasing neck pain without focal neurological symptoms. Studies revealed a compression fracture of the C2 vertebral body and invasion of the adjacent soft tissue. In order to treat the mechanical component of the symptoms, anterolateral PVP at C2 was successfully performed, but the residual suboccipital headache was alleviated only after administration of the upper cervical joint injections. Thus to treat the remained suboccipital headache after PVP at C2, upper cervical joint injections might be administered.

Key Words: injection, percutaneous, upper cervical joint, vertebroplasty.

Percutaneous vertebroplasty in posttraumatic vertebral osteonecrosis (Kummel disease)

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Introduction: Percutaneous vertebroplasty (PV) is an effective technology for different vertebral body lesions. Nowadays the indications for PV are: aggressive hemangiomas, osteoporotic vertebral fractures, vertebral body lesions in multiple myeloma and metastases and acute uncomplicated traumatic vertebral body fractures. Also vertebroplasty reduce pain and prevent further vertebral body collapse in patients with local and generalized posttraumatic vertebral body osteonecrosis (so called “Kummel disease”).

Materials and Methods: In 2000-2007 43 patients with posttraumatic vertebral body osteonecrosis were treated by percutaneous vertebroplasty (43 procedures were done). Local vertebral necrosis was found in 11
cases, generalized – in 32. PV was performed in Th12- L4 levels. The procedure was performed mostly (41 pts) under local anesthesia under fluoroscopic control. Unipedicular (36) or bipedicular (7) approaches were used. In one case additional transpeduncular stabilization after PV was done. Intraoperative biopsy was performed in 17 cases. Duration of PV – 17 – 40 min. Control CT investigations were performed immediately after an operation and after 3 and 12 months.

Results: Results were estimated according to three main criteria: pain syndrome (VAS), social activity and analgetic depending before and after the operation. There was no any clinically significant leak, pulmonary embolism or other serious complications. Effectiveness of PV was 81% in local osteonecrosis and 100% in generalized vertebral body osteonecrosis.

Conclusions: PV is a safe and effective technology for local and generalized posttraumatic vertebral body osteonecrosis. Further clinical and laboratory investigations are needed for creating clinical protocols of treatment for local and generalized posttraumatic vertebral body osteonecrosis.

A novel kyphoplasty system Xvoid®: a prospective trial in osteoporotic compression

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Purpose: A prospective, non–randomized single centre study was conducted to assess the performance and efficacy of a new kyphoplasty device (Xvoid) in the treatment of vertebral compression fractures.

Methods: Eighteen patients, who had sustained vertebral compression fracture secondary to osteoporosis (excluding high energy traumatic fractures) at least 6 weeks previously, underwent a kyphoplasty (KP) using the Xvoid device. All operations were performed using fluoroscopy under local or general anesthesia. All fractures involved the lower thoracic region (below T7) or lumbar spine. The fractures were all refractory to analgesics, physical therapy, or other conservative treatments. All subjects were operated by a single surgeon from April 2006 to August 2007. Subjects were enrolled prospectively and then clinically reviewed at 6 weeks, 3 months and 12 months after surgery. Radiographs were assessed for kyphosis, vertebral height, cement placement and cement leakage into adjacent vertebral fractures. Pain was measured using a VAS and the Oswestry disability score was used to evaluate functional outcome.

Results: The cohort consisted of 6 (33%) males, and 12 (66%) females with an average age of 73 years (range 58-94). Nine patients had co-morbidities. One patient had a neurological compromising spine disease yet no instabilities. Radiology showed 12 biconcave, 1 wedge, and 1 crush fracture. 4 patients had more complex patterns. There were 16 single level and 2 bi level fractures. The fractures had been sustained a mean of 73 days previously (range 60-84). VAS for pain was reduced from 7.9 at baseline to 4.2 at 12 months. Oswestry disability index was 30.6 points at baseline and improved to 14.7 points at 12 months. Kyphosis was reduced from 10.4 % at baseline to 4.8% at 12 months. During the clinical reviews we observed that 3 out of 18 patients (17 %) developed a new fracture. All fractures appeared in the first 12 weeks after surgery. No meaningful change in vertebral height (from baseline measurement to the latest follow up) has been observed.

Conclusion: These short term results of decreased pain and improved function are encouraging for this new treatment for vertebral compression fractures. The technique appears safe and efficient. Longer term assessment is now required.

Kyphoplasty: minimal invasive percutaneous treatment of vertebral body fracture

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Vertebral body compression fractures are very common among elderly patients and are the most seen complication in osteoporosis, often resulting in back pain, back dysfunction and substantial deficit in quality of life. It is further well known that there is a correlation between the degree of collapse of the fractured vertebral body, resulting in spinal kyphotic deformity, and the risk of subsequent vertebral body compression fractures. Therefore the aim of treating a vertebral body compression fracture is twice: reducing the pain and correcting the angular deformity to restore vertebral body height. The author prefers in addition to only inject cement (vertebroplasty) the prior restoring the of body height by a inflatable balloon (kyphoplasty). In addition we belief that kyphoplasty is a much saver procedure than vertebroplasty because by expanding the inflatable balloon one
creates a cavity with a wall of compressed spongyotic bone closing and tightening the fracture gaps which results in less cement leakage. The author has worked with kyphoplasty technique since November 2003 and has experience with vertebroplasty, kyphoplasty and Sky-bone expander (mechanical expandable kyphoplasty device). The most common indications for those procedures are osteoporotic fractures, osteolytic metastasis and compression fractures as a result of multiple myeloma. Advantages and disadvantages of those procedures, the different indications and a short overview of the literature will be the subject of the presentation.

Vesselplasty: a new concept to treat vertebral compression fractures

A 3 years follow-up study

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Object: Vertebroplasty, kyphoplasty, VEX-3000, sky expander, and optimesh systems, were percutaneous osteoplasty techniques (moulding the bone) to treat the symptomatic vertebral compression fractures (VCFs), by injection of bone filler materials (BFMs): polymethyl metacrylate (PMMA), other kinds of bone cement, and bone grafts auto- / allo-grafts or different kind of osteoinductive / osteoconductive materials. The same risks in performing the above mention techniques is leakage of BFM. The purpose of this study was to review the theory, surgical techniques, results of 3 year using this novel vesselplasty technique in restoring, stabilizing the vertebral body's height, and preventing the leakage risk of BFM.

Methods: This new concept of BFC highlights the Vessel-X™ system (A-Spine Holding Co.) as an evolution of percutaneous osteoplasty to stabilize, restore VCFs. and prevent leakage risk of BFM. Instead of previously creating a void inside the vertebral body to be filled with BFM, this system allows the delivery of a non-stretchable Bone Filler Container (BFC) into the vertebral body in deflated configuration, then inflated by injecting viscous BFM into the BFC, left as an implant and acting as a vertebral body expander. The volume of the injected BFM is controlled by a controllable cement delivery (CCD) injector system with extension tube. The pressure inside the BFC is created by the resistance of the polyethylene terephthalate (PET) container which is related to the amount of layers (1 or 2 layers), the pore size 100µ, and the container size. The optimum pressure need to lift the end plate is the amount of pressure to counteract the resistance of surrounding bone density (fresh or old fractures, young or elderly patients) and large bending moment due to kyphotic deformity. The pressure is related to the amount of BFM to be injected with pressure into a certain size of BFC. When the pressure is over the surrounding bone resistance, the BFM starts to penetrate the pores and interdigitate, thus stabilizing the BFC to the surrounding bone.

Results: A total of 103 cases of VCFs that have been treated using this novel technique is reported.

Conclusions: The Vesselplasty technique is a novel osteoplasty concept using BFC system. This technique allows the stabilization and restoration of vertebral body height of VCFs, with the advantage in controlling the volume of the injected BFM, the pressure inside BFC, also preventing the leakage of BFM, and left as an implant body expander.


A novel percutaneous bilateral facet augmentation device: biomechanics / early results

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Objectives: To assess the potential benefit of a novel percutaneous bilateral facet augmentation device in the treatment for lumber Degenerative Disc Disease (DDD).

Methods: Analysis of device biomechanical data, device insertion technique, indications and review of clinical usage to date.

Outcome Measures: Length of stay in hospital (LOS), Oswestry Disability Index (ODI) and Visual Analogue Score (VAS) for subjective pain at 6, 12, 18 months. Adverse events register.

Technique: Local anaesthesia (LA) and sedation or general anaesthesia using over the wire insertion method with sequential dilator port. The device has a titanium core consisting of a pedicular anchor screw and polycarbonate-urethane (PCU) stabilising head that augments the facet.

Results: 32 patient cohort showed; segmental stabilisation in flexion and extension with increased foramenal area and reduced disc pressures. Surgical operative time ranged between 5-20 minutes per device implanted. Length of stay ranged from 4 to 24 hours. Median preoperative ODI was 64 improving to 4.7 at 6 months and 3.5 at 1 year. VAS improved from 8.5 preoperatively to 0.9 at 6 months and 0.2 at 1 year.

Conclusions: Initial results from the use of this device in the treatment of DDD are favourable with the advantage of a minimally invasive approach. This is a simple and novel technique that may avoid early fusion surgery in some patients but a formal prospective randomised control trial and further user experience are welcomed to establish its benefits in this respect.◆

**Nucore®: an injectable in-situ curing nucleus replacement : follow-up-date in 15 cases**

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**Objectives:** Loss of disc material due to herniation 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 designed to be injected as a fluid through the annular defect and adhere to the surrounding discal tissue, thereby filling the nuclear void and restoring biomechanics.

**Methods:** A pilot clinical study is ongoing to evaluate NuCore® Injectable Nucleus as an adjunct to microdiscectomy in the lumbar spine. The material has been implanted into fifteen patients (age 23-51 years) following a microdiscectomy procedure for monosegmental radicular pain non-responsive to conservative treatment. L5/S1 was treated in ten cases and L4/L5 in five.

**Results:** All surgeries were successfully completed with an average injection of 1.2cc. Fourteen patients have completed one-year follow-up, and ten patients have completed two-year follow-up. In all cases, pain subsided as expected following standard microdiscectomy. Neurologic evaluation, Oswestry index, SF36 and VAS scores were taken pre- and post-operatively out to 24 months. Average ODI scores dropped from 44 preoperatively to 11 at 24 months post-op. Leg pain dropped from an average preoperative score of 5.8 to 0.9 at 24 months post-op. SF36 scores showed concordant improvement over pre-operative scores. MR images confirmed stable positioning of the implants. Standing plain films indicated that 90% of the pre-operative disc height was maintained at 24 months post-op; a significant improvement over the 20% loss reported at 12 months post-op in standard microdiscectomy patients (Ledic et al, NASS 2007).

**Conclusions:** These clinical results indicate that NuCore® Injectable Nucleus holds promise for improved long-term results for this relatively young patient population.◆

**Minimal access non-instrumented pars interarticularis repair using rh-BMP 2**

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Lumbar spine pars-interarticularis stress fractures [spondylolysis] are common and are often asymptomatic. Patients present clinically with localised low back pain which may be associated with sciatica if there is nerve root involvement. Typically at the time of presentation the disc at the affected level is already degenerate and
there may be a spondylolisthesis, but a small number of patients have intact discs, and the surgical option of repair of the pars defect must be considered.

Historically, the first report of a non-instrumented repair of the pars defect was in 1968; the patients lay flat for 6 weeks and had a cast for 6 months. Subsequent techniques have concentrated on repairs with instrumentation, and the complications of such surgery have been significant - wire breakage, screws loose or malpositioned, and soft tissue damage caused by the surgical access. Those papers that have adequately assessed healing have reported a non-union rate of between 15-45%

We report on our early experience using a minimal access tube [X-tube] to expose the pars defect bilaterally. The scar tissue between the bone ends is removed, and a trough is created 7-8mm long perpendicular to the defect using a Midas Rex. Care is taken to make the trough approximately 2/3rds of the depth of the bone, and to avoid disturbing the adjacent facets. The bone reamings from the Midas Rex are used to create a multilayered sandwich with BMP-2 soaked onto a collagen sponge [Inductoss]. Approximately 3mg Inductoss is used per side. A thin layer of Tisseal fibrin glue is placed over the Collagen sponge, and the wounds closed. The patient has a Thermoplastic TLSO made before the surgery and are mobilised in this brace the following day. They continue to wear the brace for three months.

Four patients [8 defects] have been treated so far. Two patients have healed bilaterally, and two have healed unilaterally, as assessed by CT scans at between 4-6 months. The clinical results have been encouraging, all patients noting clinical improvement so far. The one patient with a two year follow up has minor residual pain from the adjacent facet joints, and rates himself as 85% improved.

The technique avoids the complications associated with instrumentation, minimises soft tissue damage and preserves movement of the motion segment. We are currently working on minimal access instrumentation to see if we can make the healing more reliable. ◆

Assessment and documentation: free anamnesis vs. structured patient questionnaire

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Introduction: The 'pationnaire' is a questionnaire to assess a person/patient with any disorder of the musculoskeletal system. The questionnaire consists out of four domains, with one page each to report: symptoms, disabilities, treataments and main complaint, socio-ethno-demography, morphometry and self-perception. It is an open questionnaire meaning that all symptoms and disabilities of a person/patient can be assessed and other symptoms included if necessary.

For ease of understanding the questionnaire was designed with colors and pictograms. The questions were especially changed to "my symptoms are ..., my disabilities are ...". To improve simple utilisation and quick analysis the VCS (visual circle scale, Poster ECCEO 2005) was used (r>0.85 to VAS, Likert Scale).

The aim of this study was to test the construct validity of the 'pationnaire' with personal interviews (the agreement of symptoms and disabilities), and the ability and time to fill it out without help.

Persons/patients and methods: The persons/patients were randomly selected by the interviewer. They signed an informed consent approved by the local ethical commitee. After a short introduction about the 'pationnaire' and its aims, people filled out one directly without help. The time to completion was measured. The person/patient was then personally interviewed about items within the 'pationnaire' to assess their correlation with their symptoms and disabilities, and uncover any sources of misunderstanding or misinterpretation. At the end of the interview every person/patient was asked for a statement about their understanding, formulations, difficulties with the 'pationnaire', missing questions and general impression.

Results: 78 persons/patients (50 women, 28 men) were included. Their average age was 46.3 years (range 12 - 93 years). 97% (76) could fill out the 'pationnaire' without help, 2 needed help and further explanations. Average time for completion was 9.9 min (range 3 - 45 mins) - the longest time being taken by those who needed help. Complete agreement between the questionnaire and the perceived symptoms/disabilities was found in 94% (n=73), it was partial in 3.8% (n=3), and "no agreement" occurred in 2.2% (n=2, persons, both of whom needed support). The understanding was rated very good in 98% and difficult in 2% (both elderly persons >80 years). The formulation 'my symptoms are' was preferred by everybody compared to 'which symptoms do you have'. In general the overall rating was good or very good for all persons, although older people with co-morbidities needed help.

Discussion: The 'pationnaire' accurately documented the symptoms and disabilities present in people with active musculoskeletal disorders; it also revealed the range of symptoms. The agreement between the
answers in the questionnaire and the perceived symptoms/disabilities is high. Older people with co-
morbidities may need help to fill it out, and this can markedly reduce the rate of misunderstanding and
misinterpretation. The ‘patientnaire’ and the way to perform the interactive patient interview was welcomed by
all persons. The chosen formulation was preferred by every person/patient.
Conclusion: The ‘patientnaire’ can be used as an instrument to assess symptoms, disabilities, therapies, main
complaint, sociodemography, morphometry and self-perception. Most people (>95%) can fill it out within 15
minutes. The agreement between individual perception and answer on the patientnaire is high. ✦

German DRG in lumbar spine surgery: its impact on clinical practice, and quality?

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Germany has introduced the German Modification (GM) of the Australian DRG System (AR-DRG) in January
2004. Up to that time the hospital got paid by the insurance companies either depending on the hospital stay
of the patient or for certain diagnosis by case related payments. The introduction of the DRG system has had
an significant impact on the hospital structure and the treatment of the patients. For calculation of the
hospital budget three parameters are important:
1. Base rate (budget of the previous years/patients treated)
2. Case mix index
3. Number of treated patients

Our base rate varied between 2393€(2004) to 2675,67€(2007). For calculation purposes the cost weight for
each procedure is important. We looked at the financial impact of the DRG system for our hospital for spine
related procedures before 2004 and up to 2007.

Lumbar disc surgery: Up to 2004 the hospital got paid on a daily base rate. Keeping patients 14 days as
inpatients the hospital received 2069,34€. The introduction of the DRG system changed this calculation.
Patients have to stay at least 2 days but not longer than 19 days. Because of change of the cost weight for
this procedure the payment has dropped from an initial 3700€ (2004) to 3530€(2007).

Nucleoplasty: Up to 2004 the hospital got paid on a daily base rate. Keeping patients 14 days as inpatients
the hospital received 2069,34€. The introduction of the DRG system changed this calculation. Patients have
to stay at least 1 days but not longer than 15 days. Because of change of the cost weight of this procedure
the payment has dropped from an initial 3272,50€ (2005) to 1702,50€(2007).

Spinal fusion: Up to 2004 the hospital got paid on a daily base rate. Keeping patients 40 days as inpatients
the hospital received 5912,40€. The introduction of the DRG system changed this calculation. Patients have
to stay at least 4 days but not longer than 30 days. Because of change of the cost weight of this procedure
the payment has dropped from an initial 9717,50€ (2005) to 8912,50€(2007).

These data show that up to 2004 the hospital had to keep patients in hospital to finance certain procedures,
since than the hospital stay is not as important so far patients are not discharged before the minimum
calculated stay and not after that maximum allowed stay. The administration time for doctors has increased
significantly. The time for treating patients has decreased. As the cost weight is dropping continously and
implant cost and wages are rising the profit is decreasing so that clinical pathways are necessary. As proper
coding is more and more important hospitals employ doctors or nurses who do nothing else than check
patients medical records looking for co-morbidities and the proper DRG coding. ✦
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Our Thanks

The organizers of the course have to recognize all the supporters of this course:

Our first thanks go to the representants of the PRIVATKLINIK BETHANien for their great hospitality and multilateral cooperation for the organization of this jubilee-course.

Further we have to thank our team from BETHANIA SPINE BASE for the multiple hours of preparative work, help and input for the many organisative details around the course.

Last but not least, we have to thank our numerous industrial partners for all their input to the common goals of minimal invasive spinal surgery during all the years of common development and cooperation in this field.

Our estimated industrial contributors to this course are in particular:

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