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Conventional imaging analysis in lumbar spine: lumbar CT/myelography

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The considerably increasing number of low back pain in western societies with a prevalence of 60 – 90% is challenging on diagnostic imaging, consisting in various imaging modalities. The following techniques are available:

Native diagnostic	Contrast material / diagnostic tools
<i>standard images</i>	<i>myelography</i>
<i>special projections</i>	<i>spinal arterio- and phlebography</i>
<i>functional projections</i>	<i>discography</i>
<i>layer images</i>	<i>computed tomography</i>
	<i>magnetic resonance</i>
<i>bone activity</i>	<i>skeleton scintigraphy (technetium)</i>

Beside modern digitised conventional equipment, we use a high-resolution helical CT-scanner (PHILIPS Tomoscan 7000 AV) in our 200-bed-hospital; there are 6 MRI-equipments (up to 3 Tesla) available in the near surroundings.

The modern CT techniques, e.g. multislice scan technique, remain in many points competitive with MRI. Regarding accuracy, there is no difference, moreover, CT techniques are less expensive and radiation dose is low. We get optimal lumbar disc diagnostic results in using a combination of CT, CT myelography and CT diskography.

Diskography 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 low back pain, with or without radicular symptoms, it is reported that 13% of abnormal disks as detected by MRI had a normal diskogram appearance, while 7% of the normal disks as determined by MRI were abnormal on diskography. Radial tears and often significant changes in the peripheral structure can be difficult to visualize reliably by a native MRI scan. Diskography is also performed in an attempt to determine the presence of diskogenic pain in a definite level, and so makes an integral part of different intradiscal therapy regime, e.g. chemonucleolysis. CT myelography is used as a functional radiographic imaging technique and is indicated to clear up CT and MRI-diagnostics with complementary dynamic information. Because of its relative invasivity, its higher costs and its dose rate, this method is, however, to be used restrictively. Myelography by itself is an excellent tool for dynamic and morphologic studies under nearby natural conditions that can hardly be simulated under CT or MRI conditions alone. Sideeffects are extremely rare and consist mostly in some headache (about 1%), infectious or bleeding related problems could not be noticed in our large number of studies. Significant progress in CT-hard- and software allow us to have a more and more accurate diagnosis and is mandatory in combination with high performance X-ray tube, thin layer image, adequate segmental tilt of the gantry parallel to the disc-plane and – last but not least – overlapping slices of the interested segments.

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MRI technology in analyzing of lumbar disc disease

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This presentation is based on investigations performed at our institution. Grading of MR findings: Reliable diagnosis of nerve root compromise is possible with a relatively simple grading system (no compromise, contact of disk material with nerve root, deviation of nerve root, and compression of nerve root). Substantial intra- and interobserver agreement ($\kappa = 0.72 - 0.77$ and $0.62-0.67$, respectively) was found in 500 nerve roots. Correlation of image-based grading with surgical grading was high (surgical confirmation available in 94 nerve roots, $r = 0.86$). Lack of clinical meaning of certain MR findings: At least one bulging disk was found in 62% and at least one disk protrusion in 67% of 60 asymptomatic volunteers (20 to 50 years old). Disk extrusion was not as

common (18% of the subjects), and no disk sequestration was found. High intensity zones probably relating to anular tears were present in approximately 1/3 of the study population. In addition, endplate abnormalities were rarely found in the study population. MR findings versus provocative discography: End plate abnormalities seen on MR images predicted pain provoked by discography in 100% of the disks. Endplate abnormalities were far better predictors than discal high intensity zones (HIZ) (62% positive predictive value) and disk degeneration (72% positive predictive value). Normal MR images predicted a negative discogram. 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.

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Anatomical hints in anterior and minimal approaches to the spine

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The pathomorphologic 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 have the aim of decelerating, halting or even reversing this degenerative cascade and thus 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, cytokines, prostaglandins, hypoxidity, dehydration, loss of proteoglycans and thereby turgor (swelling pressure). This toxicity leads to irritation of the fine nociceptive nerve endings that, 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 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 distractive stabilisation of

the lumbar spine in painful mechanical dysstabilities and spinal stenosis in younger patients is briefly outlined. Dynamic restabilization at a relatively early stage is thought to unload the disc, thereby improving nutrition and rehydration. A few of these restabilization devices (a pedicle-screw system and inter-spinous-process spacers) are briefly discussed.

We also studied a great number of "postsurgical" specimens from deceased who had had posterior lumbar surgery for various lumbar disorders. Extensive scar transformation of the back muscles was consistently observed, not only of the erector trunci muscles, but also of the deep short oligosegmental muscles which account for the proprioception and fine-tuning of segmental mobility. In short as well as in long instrumentation, the scarring extended one or two levels above and below the intended instrumentation. All back muscles are contained in a non-expansile osseoaponeurotic compartment. When contracted, they constitute a powerful "dorsal soft tissue column" which stabilises the lumbar spine. Surgery must minimise violation of these muscles to avoid failed back surgery sequelae. In collaboration with Dr. H-J Leu 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 to the segmental blood vessels or neural structures, in particular the delicate dorsal root ganglia. Meticulous attention to the recommended surgical techniques it therefore called upon.

Open or mini-open conventional approaches have been considerably refined during the past few years. These all share the concept of a blunt, intermuscular dissection and avoidance of undue muscular compression by retractors. Interference with the muscular blood supply, innervation and proprioception must be minimized to avoid scarring and "fusion disease". Several tissue-sparing paramedian intermuscular approaches are demonstrated and discussed in view of the erector trunci musculature anatomy. ◆

Molecule production by fibroblasts : a basic research flash

OVINE EMBRYONIC FIBROBLASTS CULTURED ON A 3-D BIODEGRADABLE POLYMERIC MATRIX

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Introduction: Tissue regeneration by autologous cell transplantation is one of the most important goal in clinical research. In this field the development of bioactive materials that provide microenvironments for cell-matrix interactions mimicking biological conditions is required. Synthetic polymeric materials are widely used for the production of scaffolds for cell transplantation and tissue growth. Moreover many procedures have been developed in order to increase the affinity of these systems for the cells. The aim of the present study was to investigate the behaviour of ovine embryonic lung fibroblasts when cultured both on monolayer and on a poly (L-lactic acid) (PLLA) sponge-like matrix added with agarose to improve cell adhesion and growth.

Materials and Methods: Preparation of the polymeric matrices. The matrices were produced by using an emulsion freeze-drying method: an agarose aqueous solution was added to a PLLA solution in chloroform, under high speed stirring, leading to the formation of a foam. The foam was frozen in liquid nitrogen and then freeze-dried. A sponge-like material with high porosity and with interconnection between the pores was obtained and examined by scanning electron microscopy (SEM). Mercury Intrusion Porosimetry was used for a quantitative evaluation of both the total porosity and the pore size distribution.

Cell culture analysis. Fibroblasts obtained from embryonic ovine lung were seeded onto the scaffolds and cultured in a 37 °C, 5% CO₂ humidified incubator. Cell viability inside the sponges was evaluated by in vitro colorimetric tests such as MTT and Alamar Blue. Samples were also fixed in neutral formalin and paraffin-embedded: cell morphology was analyzed by haematoxylin-eosin while the production of matrix molecules was evaluated by Alcian blue, PAS and Van Gieson technique. Fibronectin and collagen expression was evaluated by immunocytochemistry. Cytochemical and immunocytochemical analysis were also performed on the fibroblasts grown on monolayers.

Results: Porosimetric analysis indicated a pore size distribution ranging between 8 and 110 microns with a maximum at about 40 microns that shifted toward about 25 microns after six hours exposure to solvent vapour. MTT and Alamar Blue tests demonstrated that transplanted cells were viable and metabolically active. Morphological analysis revealed that fibroblasts adhered and penetrated the polymeric structure. Moreover, it was observed that fibroblasts cultured on the scaffolds were able to produce proteoglycans, glycoproteins and matrix molecules. Immunocytochemistry revealed that these fibroblasts also expressed fibronectin and collagen.

Conclusion: This study demonstrated that fibroblasts from embryonic ovine lung are able to adhere and grow on 3-D Agarose-PLLA matrices and to produce matrix molecules. The behaviour of these cells onto the three-

dimensional structures and on monolayers was quite similar. On the basis of these results the matrices, investigated in this study, appear very promising for applications in tissue regeneration. ◆

Minimal invasive CT-based use of kryoprobes at the spine : an animal study

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Cadaver and animal studies as well as first clinical usage have shown that with miniature kryoprobes it is possible to achieve a tissue cooling in bone without any general complications. With this study we can show that it is possible to use this system in a minimal invasive manor with the help of a navigation system and a CT based plan. We used the vertebral spine as many primary and secondary tumors affect the spine.

Using 3 pigs we were able to use kryotherapy in 15 vertebra under general anaesthesia. We placed the probes using our brainlab navigation system. With the help of our virtual planning system we were able to use the kryotherapy without harming any neurovascular structures. We used two cycles each over 15 minutes with 5 minutes warming periods in between. There were no peri- or postoperative problems with the animals. The analyses of the obtained vertebra showed the necrotic bone as planned without interference with pedicles and vertebral cortex. There was a high correlation with the preoperative plan. We believe that the minimal invasive treatment of vertebral bony tumors is possible with the combination of miniature cryoprobes, CT-scanning and a already available navigation system. ◆

Anatomical investigation on epiduroscopy and first clinical experience

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Patients with chronic back pain are an unsolved problem for back specialists. Beside thorough clinical examination MRI scans are often used to look for herniating discs or scaring after back surgery. Still there is a poor correlation between evidence in the MRI scan and the patients symptoms. Treating these patients is also a problem. Reoperations provide only poor clinical outcome. We use the so-called SSPDA (single shot peridural anesthesia) as a treatment option in these cases. Looking for better methods for visualisation of epidural pathologies we thought that epiduroscopy might be of good value in these cases.

Analysing the available literature we found articles reporting detection of pathological processes not being visualized in other modern imaging techniques. Still user report of limited use due to technical difficulties and poor visualisation. Especially showing only the posterior part of the epidural space without visualisation of the ventral epidural space and the disc.

We therefore took fresh half cadaver specimens. The epiduroscope was introduced in typical manner via the sacral hiatus. Protruding the scope to the sacral rim the scope took the posterior way due to the dural attachment at the sacrum. The only way to reach the anterior epidural space is to bend the scope anteriorly and to perforate the dural cavity. Using this manoeuvr visualisation of the anterior epidural space is possible. A controlled perforation would be favourable using therefore designed instruments ◆

Today's epidemiology of lumbar degenerative disease

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The natural history of disc prolapse is not to recover. Bose has revisited Weber's work of 1982. In Weber's analysis he found that at five years there was very little difference between surgery and non-surgery. Bose has found that Weber's statistic analysis is incorrect in terms of cross over, these patients do not get better. Using the Cochrane Library we know the best treatment for sciatica. This does not answer the question of control of back pain. It would appear that medicine does not seem able to do this. The only means of cutting back is by political will. Spinal fusion has been suggested as a means of dealing with this. From the Swedish and British Spine Stabilisation trials surgery is slightly better than no treatment, but the results of maximum surgery are no better than minimal surgery. 360 degree surgery with anterior and posterior implants have a 40% complication rate and are no better than simple posterior lateral fusion with 12% complication rate. Do big operations justify the complication rate compared to the end result; the answer is no. Rehabilitation seems to be a better means of dealing with back pain. Back pain in isolation is probably not a surgical problem. ♦

The lumbar facet syndrome: diagnosis and actual treatment

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Introduction: Study of the lumbar facet joints is a focus of attention in orthopaedic world for many decades already. At the Sytenko Spine Institute above problem has been developed for more than 25 years.
Purpose: Estimation of possible of diagnostics and treatment of patients with a lumbar facet syndrome
Materials and methods: We used morphological material of 56 facet joints of the lumbar spine taken in the course of the operation of the posterior lumbar interbody fusion on levels L₄₋₅ and L₅-S₁ for various structural and functional disorders of the lumbar spine; 52 arthrograms of the facet joints.
Results of intraarticular blockades (518 patients)
Comparison of the results of the facet joints blockades was conducted in 2 group:
I-st group : the blockades performed under radiological control with preliminary arthrography;
II nd group : without arthrography.
The facet joints denervation – 385 patients.
The percutaneous lumbar facet joint fusion – 12 patients.
Results: Morphological investigation demonstrated the whole range of changes characteristic for the synovial joints.
By data of the articular arthrography the picture peculiar to instability, severe arthrosis was determined. In 3 cases diverticuli of the upper turn of the facet joint markedly influencing the formation of clinical symptoms were identified.
The results of the intraarticular blockades in the 1st group were good - 65%, satisfactory - 33%, unsatisfactory - 2% . In the 2d group they were good - 58%, satisfactory – 35%, unsatisfactory - 7%.
In case of unsatisfactory results denervation of the facet joints by means of electrocoagulation or cryodestruction was performed. The results of facet denervation were satisfactory in 75%. After facet joints fusion good results has been 9 patients.
Conclusion: Variable changes of the facet joints of the lumbar spine play a significant role in the formation of pain syndrome and their diagnostics and treatment demand a special consideration. ♦

Mid-term results with percutaneous cryodenervation of lumbar facet joints

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Background: Lumbar zygapophyseal joints are a frequent source of pain in degenerative lumbar spine disease. In many cases, they may actually be the predominant source of pain. Amongst the minimally invasive therapies, efficacy has previously only been demonstrated for radiofrequency denervation.

Study Goal: This study prospectively investigates the effects of percutaneous cryodenervation of lumbar facet joints.

Material & Methods: Our target criteria were low back pain (VAS 0 - 10), limitation in daily activities and general acceptance of the treatment method. Inclusion criteria: Deep-seated non-sciatic low back pain, failure of conservative measures, positive diagnostic medial branch blocks.

Exclusion criteria: Previous spinal surgery, relevant spinal stenosis, activated osteochondrosis, radicular pain. Diagnostic blocks were performed under fluoroscopy, improvement in low back pain of more than 50% for more than 3 hours was considered a positive block. Cryodenervation was performed also under fluoroscopy at a separate appointment. Since June 2002, 52 patients (average age 56) were entered into the study. 2 Patients were lost to follow-up and 2 others had to be excluded, so that 48 patients were available for evaluation. At present, we have a 3-month follow-up for all 48 patients, a 6-month follow-up for 44 patients, a 12-month follow-up for 32 patients and an 18-month follow-up for 19 patients.

Results: 2 weeks after treatment, 65 % of patients reported significant improvement, 35 % reported little or no change in pain. The average VAS of the complete study group dropped from 7.7 preoperatively to 3.3 at two weeks and to 3.45 at three and eighteen months postoperatively ($p < 0.05$).

Limitation in daily activities improved parallel to the reduction in low back pain and 33 out of 48 patients would have the procedure performed again while 2 remained undecided.

Conclusion: Percutaneous medial branch cryodenervation is a safe and effective means for the treatment of lumbar facet joint pain.

Nucleoplasty in contained disc herniations : 24-months follow-up

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Study Design : Prospective non-randomised case series study with 24 months follow-up.

Objective To evaluate the effectiveness of percutaneous intradiscal radio frequency plasma discectomy (Nucleoplasty) treatment in patients suffering from low back and leg pain due to contained disc herniations.

Methods: Thirty-three patients, 12 females and 21 males, aged between 26 and 56 years (mean $50 \pm$ s.d. 11.5), were enrolled in the study on the basis of precise inclusion and exclusion criteria. All the patients were followed by Visual Analogic Scale (VAS), Roland Morris Disability Questionnaire (RMDQ), Overall Patient Satisfaction Rating (OPSR).

Results: Five patients were lost to 24 months follow-up: 3 patients were submitted to surgery in a period from 12 to 24 months post-treatment (2 for different spinal problems and one for the same level problem); 2 patients were not reachable (one changed the treatment and physician and the other was not reachable) All of this were considered as failures of the treatment. In the remaining group of 28 patients (85% of total) the 24 months follow-up showed a statistically significant improvement in pain of 3.1 points ($P < 0.001$, Wilcoxon test), and in function of 4.87 points ($P < 0.001$, Wilcoxon test), on VAS and RMDQ evaluation, respectively. The mean satisfaction with the treatment on OPSR was 72,67%, with 22 patients referring satisfaction equal or greater then 70%. There were no major complications related to surgery.

Conclusions: Intradiscal percutaneous radio frequency plasma discectomy (Nucleoplasty), seems to be an effective and safe treatment option for carefully selected patients affected by low back and leg pain due to contained disc herniations.

Key words: disc herniation; minimally invasive; radio frequency; surgical procedure; low back pain;



Percutaneous endoscopic disc surgery : evolution and actual foraminoscopic concept

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Having seen for several years the positive clinical experience with biportal endoscopic percutaneous intradiscal applications for decompression since 1982 and fusion procedures since 1988, the idea to combine simultaneous endoscopic control with direct tissue elaboration across a uniportal approach emerged in the late eighties. Experiments with modified urologic working-scopes designed for cystoscopy 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 foraminoscopy clinically for the first time in February 1991 for the treatment of a foraminal sequestered herniation. Since then the technology 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 sequester, which is extracted under endoscopic control then with a special working scope. Our first clinical series of 150 cases brought successful results in 123 cases, including an initial learning curve. 21 patients needed later on conventional open surgery w/wo fusion. Here the results trend to "black or white" : or the sequester is removed or not. Relatively freshly sequestered fragments are easier to remove. Detailed knowledge of foraminal anatomy is mandatory. Hospital stay could be reduced to 2 to 3 days, out-patient care is possible as well. ♦

Endoscopic percutaneous versus open microscopic technique in far lateral herniation

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Objective: The aim of the present study was to compare the percutaneous endoscopic technique (PE) and the open microsurgical decompression by posterolateral approach (OM) in the treatment of far lateral lumbar disc herniation.
Methods: Between 12/1996 and 07/2004 130 patients were surgically treated for far lateral lumbar disc herniation (89 PE and 41 OM). Mean age was 56 yrs. (20-79 yrs.), 62 male and 68 female. There were no significant differences in both groups concerning age, sex and levels. Fluoroscopic monitoring was used in PE: A working channel was introduced 8-12 cm from the midline and the nerve root decompressed under endoscopic visualization according to Mathews et al. OM procedure: Skin incision was done 8 - 12 cm from the midline, to approach the foramen according to O'Brien et al. Follow up was done in frequent intervals. Data were collected from the patients' records and analysed with t-test and chi-square ($p < 0,05$).
Results: In the PE-group, significantly less postoperative complications, time of surgery significantly shorter, consumption of analgetics much lower and postop. hospitalization time significantly shorter.
Conclusion: Percutaneous endoscopic surgical technique (PE) proved to be superior to the open microdiscectomy (OM): Shorter time of surgery, less consumption of analgetics, shorter duration of hospitalization.
Literature : O'Brien, et al.: J Neurosurg 83:636-640, 1995. Mathews HH, et al.: Neurosurg Clin N Am, Jan 1996, 7(1) p 59-63 // **Keywords:** Disc Herniation, Percutaneous Discectomy, Endoscopy ♦

Fully endoscopic transforaminal/interlaminar lumbar decomp. using new instruments

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The therapy of degenerative diseases of the lumbar spine involves both medical and socioeconomic problems. In lumbar disc herniations, a surgical procedure may be necessary if conservative measures have been exhausted and states of exacerbated pain or neurological deficits persist. Despite good therapeutic results with conventional operations, there may be consecutive damage due to traumatization. Thus, it is important to continuously improve these procedures. Taking existing quality standards into account, the objectives must be to minimize operation-induced traumatization and negative long-term sequelae. Current research results and technical innovations must be critically applied in order to guarantee the best-possible treatment strategies.

Minimal-invasive techniques can reduce tissue damage and its consequences. Endoscopic operations under continuous fluid flow bring advantages which raise these procedures in many areas to the standard level. Lumbar transforaminal procedures with posterolateral access have been used for more than 20 years. The work area is predominately intradiscal and intra- and extraforaminal. In recent years, a lateral transforaminal and an interlaminar access have been developed to enable a full-endoscopic approach to disc prolapses located within the spinal canal. Considering the indication criteria, this provides sufficient decompression under visual control, equal to that of conventional procedures, but with all the advantages of a truly minimally-invasive procedure. Using these accesses, most of the herniated discs located within the spinal canal or intra- and extraforaminal can be operated full-endoscopically.

Problems arose technically from small and not actively-flexible instruments coupled with a small intraendoscopic work canal. Insurmountable difficulties could arise in the resection of hard tissue, the anatomic access, the mobility and the elevated recurrence rate. New optics with an intraendoscopic 4-mm work canal and corresponding instruments, as well as shavers and burrs were developed with the objective of permitting full-endoscopic operating under visual control. The mid-term experience now reported with these new operation instruments shows nearly total elimination of the technical problems. In addition, the indication is broadened with respect to techniques for spinal canal decompression and fusion. But the technical development has not yet been completed, and there remain clear indications and limitations. ◆

Retroperitoneal and percutaneous foraminal endoscopic approach to the

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A retroperitoneal laparoscopic (retroperitoneoscopic) lateral approach and percutaneous endoscopic foraminal approach achieve decompression for a far lateral disc lesion in the lumbar spine or removals of paravertebral neurinoma without disrupting the facet are described. This new surgical technique is presented in detail, and the results from surgical trial are reviewed. The incidence of a lumbar disc herniation lateral to the facet has been reported to be between 0.7 and 11.7% over all sites of a lumbar disc herniation. Some cases have been reported in which all fragments compressing the nerve root were removed without destruction of the overlying facet joint but with some limitations. The retroperitoneoscopic lateral lumbar approach to levels L1-2, L2-3, L3-4, L4-5, L5-S1 is described. This approach uses balloon inflation to form a retroperitoneal surgical cavity under endoscopic vision through the transparent balloon membrane. The operating space is maintained using a powered mechanical lift and a flat inflatable retractor mainly or pneumoperitoneum procedure to make a longitudinal separation between the psoas major and the quadratus lumborum. The far-lateral disc herniation is excised through the lateral side with retraction of the spinal nerve root under retroperitoneoscopy. This approach permits the use of a conventional spine instrument for removal of the disc herniation. Magnification of the image through the retroperitoneal scope provides the surgeon with a very accurate identification of the anatomical structures.

We have successfully performed this technique in 78 cases using retroperitoneoscopy and 56 cases using percutaneous endoscopic foraminal approach. The best indications of this new retroperitoneoscopic lateral procedure are lateral disc herniation at the L5-S1 level or around the epiconus at the L1-2 level. It is too early to tell if the described procedure provides adequate exposure necessary for extraforaminal exploration, discectomy and nerve root decompression and is sufficient for treatment of extreme lateral lumbar herniation localized to the L1-S1 level and for the treatment of a spinal nerve root tumor. ◆

Indications/clinical outcome of posterior endoscopic surgery in lumbar radiculopathy

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The Microendoscopic discectomy (MED) system that has been developed in recent years has enabled us to remove lumbar disc herniation as accurately as when the standard open procedure is used. Since 1998, we have performed posterior endoscopic surgery using the MED system for lumbar radiculopathy. We will present our findings about the safety and clinical outcomes, in addition to clarifying the indications and problems of the MED system for cases of lumbar radiculopathy.

Materials and Methods: From September 1998 to December 2003, 492 consecutive patients underwent posterior endoscopic surgery for lumbar radiculopathy. The mean follow-up periods were 3.2 years postoperatively. There were 386 cases of lumbar disc herniation, 11 cases of posterior endplate lesions, 90 cases of lumbar canal stenosis. We investigated operation time, blood loss, recovery period for the resumption of walking, inter and postoperative complications and clinical outcomes by using the Japanese Orthopedic Association scores (JOA score). **Results:** Operative results were 13.4±5.1 preoperatively improving to 26.3±3.1 at postoperatively, and 27.6±2.2 at final follow-up for lumbar disc herniation and 16.9±3.6 preoperatively improving to 27.1±2.3 at postoperatively and 28.2±1.6 at final follow-up for lumbar endplate lesions. Complications were seen in 20 (4.0%) as follows; 8 cases of dural tears, 3 cases of misjudgment of operative locations, 5 cases of postoperative hematoma, 1 case of pyogenic spondylitis and 3 cases of transient motor weakness. The re-operation rate was 2.4% (14 cases).

Discussion : regarding the level of difficulty for the indications of posterior endoscopic surgery, firstly we should address the intervertebral disc level herniation in its initial stage. Moreover we can address migrated disc, central disc and, far-lateral disc herniation even in an advanced stage. Next we can address the most difficult surgeries, the recurrence of disc herniation, lumbar canal stenosis or cervical radiculopathy even in highly advanced stages. However because the learning curve is very steep, the skills needed to address the more advanced stage rises accordingly. Concerning the surgical field of view, the MED is expanded by using the adjustable endoscope. Furthermore, we can address inaccessible areas; for instance beneath the nerve root or the contra-lateral side. In conclusion, the MED system allowed for not only removal of herniated disc, but also decompression of the nerve root and dural tube in cases of lumbar canal stenosis and cervical radiculopathy, thus achieving excellent clinical results. Therefore, it was considered that this method might become a new innovative technology in the spinal surgery field.

Conclusion: MED were indicated for not only lumbar disc herniation, but also for posterior decompression surgery. This endoscopic decompression minimizes resection of the pathologic compression tissues and affords a safe procedure. Our clinical outcomes demonstrated excellent and good patient satisfaction in most of cases. ♦

Translaminar epidural endoscope in lumbar hernias and lateral recess stenosis

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During evolutive history of three joint complex in degeneration in lumbar spine occur changes that cause significant modifications in the normal anatomy. The selection of surgical technique is according to solve totally the factors of compressions in side of rachideal canal.

The reality of this frame is that many cases is a combination of situations such as herniated disk combined with hypertrophy of facet joint, ligamentum flavum wrinkle (hypertrophy) after vertebral body descent, adherences in old hernias, natural narrow recess, synovial facet ganglion, degenerative lateral recess stenosis-hernia, osteophytosis. Long – term pain relief with less morbidity, conservative anatomy and the preservation of normal motion of segment is the surgical target.

The translaminar Epidural Endoscopy, TEE (Arthroscopy vol 12, nº 3, 1996), is a bi-portal surgical endoscopic procedure by posterior approach, trans-flavum ligament with triangulation and optical instrumental accuracy. Provide a clear image inside/outside the rachideal canal and in side the disk, allows the navigation through epidural space recognizing the anatomy the pathology and clear understanding the factors of compressions.

With less risk and morbidity we can treat those cases with simple and combined pathology. The surgical procedure should be orientated to resolve all of possible factors along of the natural history of degeneration. The natural evolution of TEE to consist of: the capability to make endoscopic interbody fusion or implant of artificial nucleus pulposus, dynamic stabilization. ♦

Percutaneous endoscopic and microscopy-assisted nucleotomy in lumbar herniation

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The percutaneous endoscopic nucleotomy of contained lumbar disc herniation has been in use in our department with carefully selected patients since 1990. Essential for the success of this method is a careful diagnosis to decide the right indication. With the first 164 patients (1990-1997) the postoperative follow up checks have been carried out for 5 to 13 years. The average age of patients operated on was 43 1/2 years (ranging from 23 to 64 yrs) for male patients (n = 102) and 40 years (ranging from 22-62 yrs) for female patients (n = 62).

The level of disc removal was mainly L 4/5 (n = 126) and in 38 cases L 3/4. 123 patients (75 %) had got therapy-resistant low back pain and radiculopathy, and 41 patients (25 %) had got therapy-resistant low back pain only. The patients suffered from relevant symptoms for six months on average (3 months - 2 1/2 years) before consulting our department. The preoperative diagnosis applied consisted of standard X-ray of lumbar spine and CT, in 95 cases (58 %) additional MRI and in 37 cases (22.6 %) a further myelography with subsequent myelo CT was applied. In all cases the decision on the final operative procedure was taken after an intraoperative discography. The postoperative follow up check was done 5 - 13 years (7.7 years on average) and it revealed excellent and good results with 116 patients (70.7 %) and fairly good results with 21 patients (12.8%). 27 patients (16.5 %) showed persistent neurological symptoms postoperatively. 12 out of them needed conventional microdiscectomy 3 weeks to 6 months later, another 5 patients within 12 months and another 3 patients 2 or 3 years later resp. We have had no major complications. For cases of contained disc herniations this is still a highly effective minimal invasive operation method.

For some time now we have been gaining experience with microscopic - assisted percutaneous nucleotomy in lumbar herniation using the conventional dorsal approach. The advantage of this method compared with the open microsurgical technique is the smaller minimal traumatizing access required through transmuscular dilatation by offering optimal three-dimensional visualisation of the surgical field. ♦

Endoscopic laser assisted discectomy for cervical/thoracal/lumbar herniations : 8199 cases

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Minimally invasive spine surgery has been developed out of the desire to effectively treat spinal diseases with preservation of normal healthy structure, bloodless spinal surgery, and rapid recovery. Now, thanks to development of endoscopy, video system, and laser technology, the minimally invasive surgery can be performed using a percutaneous approach under local anesthesia without injury to muscle, bone, and nerves.

There are two kinds of percutaneous disc treatments: percutaneous laser-assisted disc decompression (PLDD) and percutaneous endoscopic laser-assisted discectomy (PELD).

PLDD using automated nucleotome, microforceps and Laser Assisted Spinal Endoscopy (LASE; Clarus) through a same 2.5mm working sleeve is performed in patients with contained soft disc herniation in the cervical, thoracic, and lumbar spine. LASE, which integrates Ho:YAG laser, endoscopy, illumination, and irrigation, allows for vaporization and shrinkage of disc tissue through a small cannula (1.7mm in diameter). PLDD with LASE was done especially for targeted posterior decompression and posterior annuloplasty to treat low back pain due to IDD or DDD with mild protruded disc. The main advantages of PLDD with LASE are collagen remodeling, nerve modulation, and preservation of normal central disc tissue without development of segmental instability.

PELD with 6.5mm working channel endoscope (KISS of EKL or YESS of Wolf) is performed for large sized extruded migrated or ruptured disc in the lumbar spine. WSH endoscopy kit (Storz) is used for manual and side-firing laser discectomy under clear visualization in patients with extruded, ruptured, and foraminal cervical disc

herniations. However, the thoracic ruptured extruded disc should be treated by transthoracic or thoroscopic surgery, so that those cases were excluded in this study.

For the placement and manual discectomy, X-ray fluoroscopic guidance is usually used in the cervical and lumbar regions. The author has used CT-fluoroscopic guided decompression in the thoracic disc disease. It provides accurate spatial information and real-time information.

From Jan 1999 to Nov 2004 a total of 8199 patients underwent percutaneous endoscopic procedures at Wooridul Spine Hospital (WSH). There were 5114 (62.4%) male and 3085 (37.6%) female patients who ranged in age from 13 to 90 years (average 40.9 years). Lumbar region (94.9%) was the most common region, followed by cervical region (4.8%) and thoracic region (0.3%).

The mean success rate was 89% over all patients: 82.4% in the cervical region (85.9% in PLDD and 80.2% in PELD) and 88.3% in the lumbar region (92.7% in PLDD and 87.5% in PELD), 76.2% in the thoracic region. These results are comparable to those of the traditional open surgeries. The overall rate of conversion to open surgery was 6.3% and the occurrence rate of transient dysesthesia (up to 4 weeks) was 12%, and the occurrence rate of transient weakness was 0.1%. There were 12 cases of discitis. One of the most important things to prevent discitis is pumping irrigation with a saline containing antibiotics through irrigation forceps and irrigation laser. There were no mortality and no permanent neurological deficit, at all.

In conclusion, PLDD with LASE was safe and effective in patients with contained soft disc herniations. PELD with working channel scope was the choice for extruded migrated discs. These procedures could be considerable alternatives for the patients who cannot or do not want to conventional open surgeries under general anesthesia.



Percutaneous laser diode disc decompression (PL3DTM) - 600 cases' experience

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The classical microsurgical approach in the treatment of herniated disc disease has been substituted over the years both by endoscopic approach in which it is possible to practice via endoscopy a laser thermo-discoplasty, both by percutaneous laser disc decompression and nucleotomy. In the last ten years, the percutaneous laser disc decompression and nucleotomy have been done worldwide in more than 60000 cases of herniated disc disease. Because water is the major component of the intervertebral disc, and in herniated disc disease pain is caused by the disc protrusion pressing against the nerve root, a small reduction of volume in a closed hydraulic space, such as an intact disc, results in a considerable fall of intradiscal pressure. The 980 nm Diode laser is the optimal wavelength for laser disc decompression, because 980nm is 10 times more absorbent in water than 810nm, and 5 times more absorbent than 1064nm. A MULTIDIODE PL3DTM (INTERmedic) - 980nm wavelength Diode laser energy introduced through a 400 micron silica-silica fiber with a special high temperature polyamide protection (INTERmedic - FiberTech) into a 21G needle under X-ray guidance and local anesthesia, vaporizes a small amount of nucleus polposus with a disc shrinkage and a relief of pressure on nerve root. The gas formed due to the vaporization of the nucleus is removed by a specific handpiece (Menchetti's handpiece) connected to a smoke evacuation system, to minimize the postoperative muscle spasm. Most patients get off the table pain free and are back to work in 5 to 7 days. Material and method: to date, 480 patients (600 cases) suffering for relevant symptoms therapy-resistant 6 months on average before consulting our department, affected by contained (protrusion, subannular extrusion) and noncontained (transannular extrusion) disc herniation have been treated. Only free disc fragment has been detected as an absolute contraindication. Three hundred-twenty (67%) males and 160 (33%) females had a percutaneous laser disc decompression and nucleotomy. The average age of patients operated was 46 years (16 - 82). The level of disc removal was L2/L3 in 26 cases, L3/L4 in 58 cases, L4/L5 in 294 cases and L5/S1 in 222 cases. Two different levels were treated at the same time in 64 patients, and three different levels in 28 patients. In 44 cases the PL3DTM has been performed after an unsuccessful microsurgical approach with a relapse of the disc herniation. Results: The success rate at a mean follow-up of 22 months was 91% with a complication rate of 0.5%. No septic discitis has been detected. Because of the best absorption of the water content of the disc by the 980nm wavelength laser, compared to others lasers (810nm, 940nm, 1064nm), 980nm Diode laser requiring less laser energy with a less heat diffusion in surrounding tissue, reduces postoperative complications, and appears to be more safe and effective. Conclusion: The MULTIDIODE PL3DTM (INTERmedic) appears to be a specific and optimized laser system for discectomy treatment, specifically designed in order to apply the optimal wavelength for disc decompression and nucleotomy. The technique is minimally invasive, is performed in outpatient environment, requires no general anesthesia, results in no periradicular scarring or spinal postsurgical instability, is cost reducing and does not preclude microsurgery if needed. ◆

Polysegmental percutaneous 1064nm-ND-YAG-laser nucleotomy in soft spinal stenosis

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17years after introduction of the Nd-Yag-Laser for intradiscal therapie for discogenic vertebrogenic pain syndromes by Ascher and Choy, we have a positive conclusion with a succes rate of 80% at the lumbar spine, 87% at the cervical spine and 93 at the thoracic spine. The complication rate was at all under 1% in more than 3000 procedures.

The discogenic vertebrogenic pain syndroms are divided into local, pseudoradicular, radicular, medullar (Conus-Cauda-Syndrome) and vegetative (claudicatio neurogenica) Syndromes. The comparison of the pictorial pathology confirmed by MRI or MRI-Myelography in connection with the result of the clinical examination allows the decission for the use of an intradiscal therapy by resistance of conservative therapy before the step to open decompression or fusion.

The spinal stenosis contains three main components, the hypertrophy of the liagaments, bone narrowing and the narrowing by the disc. The discal component could be caused by bulging, protrusion or even extrusion. Meanwhile a direct operative treatment of the dorsal components have no doubt, the discal components are often treatet only indirectly. But the ventral part of the spinal channel plays an important role in the spinal stenosis cause of the vascularisation. So th intervention of the disc is useful. The often within the scope of the combined discoosteoligamentous spinal stenosis existing vegetative syndromes with the known symptoms and a reduced walking distance make the decission to the PLDN recommendable before open surgery. The succes is founded on the excellent shrinkage of the disc, the vaporisation and the intradiscal/intraspinal pressure decrease by using the Nd-Yag Laser 1064nm, the low complication rate in multilevel use and easy handling multisegmentally.

From the beginning of this therapy in 1989 we included polysegmental indications. Especially polymorbid patients in higher age are without problems indicated because of the minimalism of this procedure. The results and the complication rate are the same as by monosegmental therapy . The most important profit is the extension of the painfree walking distance.

Conclusion: We can find out that the nonendoscopic percutaneous laserdiscdecompression and -nucleotomy with the Nd-Yag-Laser 1064nm in multilevel use by spinal stenosis is suitable for the treatment of the discal part of this disease because of the high improvement of the findings and low complication rate. It is recommended as the last step before open surgery. ◆

2 year's data Maverick (LDP): European and US IDE studies

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The First Prospective Two Year Minimum Follow-up of Metal-on-Metal Maverick Total Disc Replacement {TDR} Study Co-Authors : Hallett H. Mathews, M.D., Jean-Charles LeHuec, M.D. PhD., S. Aunoble, M.D., Tai Friesem, M.D., and Thomas Zdeblick, M.D.

Introduction : Motion preservation represents a new trend in the surgical management of degenerative disc disease. The Maverick TDR has been designed as a metal-on-metal prosthesis that clearly mimics the center of rotation of the damaged degenerative segment. By restoring height, stability, and functional load bearing of the diseased interspace, many believe that this functional restoration may prove a better long-term solution to degenerative disc disease as opposed to the gold standard of interbody fusion. This TDR Study is thought to be the world's first minimum two-year prospective series of 64 consecutive patients receiving the Maverick Metal-on-Metal TDR in a clinical setting.

Purpose : The purpose of this study was to evaluate the ODI, VAS, and SF36 of a two piece metal on metal TDR, with the correlation of facet arthritis, canal stenosis, and muscle fatty degeneration on pre-op MRI studies to these outcomes.

Methods and Materials : The Maverick TDR is two-piece ball-and-socket, cobalt chrome on molybdenum design with a posterior center of rotation mimicking the intact spinal segment. The effectiveness of the device was characterized by evaluating VAS for back and leg pain, Oswestry, SF36 and x-ray analysis of range of motion sagittal balance, and complications were recorded. Oswestry's success was calculated as an FDA mandated

25% improvement with a VAS success as a two-point improvement. A total of 64 patients followed for a minimum of two years; average age = 45.5 years, 38% male and 62% female. A total of 31 patients @ L5-S1, 32 @ L4-L5, and 1 patient @ L3-L4 implantation. Surgical time was 58 to 225 minutes with L5-S1 averaging 65 minutes and L4-L5 averaging 96 minutes. Blood loss was 100 to 250 cc. All complications were recorded as related to the implant, insertional technique, or patient selection criteria.

Results/Findings : The average Oswestry improvement was 40% for 64 patients. The success rate of greater than 25% improvement in the Oswestry scores was 79% with a P-value of less than 0.0001. The VAS back pain improvement was statistically significant at 0.0001. SF36 improvement was 85% physical and 43% mental. The presence of Modic type 1 or type 2 disc degeneration had no influence in the clinical outcome of patients with disc replacement. Also, grades 0, 1, and 2 of facet arthrosis had no influence in outcomes, with grade 3 and grade 4 emphasizing significant degenerative facet disease having a negative influence on outcomes after Maverick TDR. Preoperative MRI determination of muscle fatty degeneration was a negative influence if greater than 50% of the muscle posteriorly had fatty infiltration. Complications were related to the anterior approach, which were ureter tear (1), common iliac vein (1), both repaired, and technique-related orientation of the prosthesis and posterior wall fracture. There were no implant-related complications. Two superficial wound dehiscence resolved without further surgery.

Conclusion : This study represents the world's first minimum two-year follow-up collected in a perspective fashion of 64 consecutive patients, not including any training cases, undergoing Maverick TDR. ODI and VAS scores were statistically significantly improved postoperatively and negative correlation was noted with muscle fatty degeneration and advancing facet arthrosis. No correlations were determined between Modic changes and clinical outcome. This study represents a foundation of prospective data for long-term analysis of all disc replacements. ◆

Backage in medical History

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Historically investigating our actual understanding of today available sources, spinal surgery, in comparison to trauma-related or septic surgical procedures, due to its 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. ◆

Innovative and Digital Technologies in Minimal Invasive Endoscopic Spinal Surgery (MISS) for Spinal Motion Preservation

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INTRODUCTION: Evolving minimally invasive spine surgery (MISS) has rapidly come of age,¹⁻⁵ with better endoscopic spinal surgical instrumentation, the explosive development of bio-computer and bio-technology, digital video imaging, laser application^{6,7}. A new algorithm in the spine care has been redefined and established. Medical professionals expect that up to 85% of spinal surgery will soon be done with endoscopic MISS technique.⁸

MATERIAL AND METHODS: Recent innovative endoscopic MISS instruments, various spinal endoscopes,³ intra-operative digital x-ray fluoroscopy, digital video photography, various laser application, newer endoscopy for better visualization, and thermodiskoplasty (i.e. the use of the laser at low energy levels, to shrink and tighten disc material)^{6,7} are described. Endoscopic MISS techniques used in surgery are demonstrated pictorially.^{6,7,9-11} Many digital computer aided innovations¹ including surgical robotics, image guided technology and various endoscopic MISS systems are demonstrated.

A well designed digital Institutional Information System (IIS) including a Picture Archiving and Communication System (PACS),^{1,12} and a digital 3-D imaging virtual reality system in a surgical planning laboratory¹ provides precise diagnosis and pre-operative surgical planning in order to facilitate MISS. This network with the IIS provides intramural and extramural connectivity. Digital video game technology, heptic technology and surgical simulator are on the horizon¹³. These establish the foundation for telemedicine, telesurgery, teleconferencing and advanced digital endoscopic surgical suite for better patient care, education, research, development and endoscopic surgical training¹²⁻¹⁷.

RESULTS AND DISCUSSION: Minimally invasive spine surgery outcome has improved the overall success rate to above 91% or more (94% for one level) with less than 1% of morbidity and zero mortality as demonstrated in the recent multicenter study.¹⁶

The rapid progress in endoscopic MISS has been facilitated by digital technology. There is a definite correlation between clinical findings, digital radiology, neuropsychological studies, MRI, CT, 3D virtual imaging, virtual spinal endoscopy and surgical findings. Digital video game technology, heptic technology and surgical simulation will assist in the training of the minimally spine surgeons¹³. Surgical robotics and image guided technology¹ for MISS are on the horizon.

CONCLUSION: Endoscopic MISS has rapidly become of age and has many obvious advantages.^{7,10,11,16} Digital technology assists in the advancement, development, the training, and the practice of endoscopic MISS for treatment of degenerative disc disease, and preservation of segmental spinal motion. This minimally invasive, less traumatic, outpatient endoscopic MISS treatment leads to excellent results, faster recovery, and significant economic savings. In the near future with the assistance of digital technology, endoscopic MISS applications will further provide an excellent and effective access or platform for spine arthroplasty, spinal disk replacement, artificial disk, vertebralplasty, spinal fixation/fusion, disc re-growth technology and potentially genome therapy.

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Drill-tunnel foraminotomy va anterolateral approach of the cervical spine

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Introduction : Drill-tunnel cervical foraminotomy was performed on 320 cases of foraminal or posterior osteophyte and disc herniation.

Clinical material and method : Principle of patient selection is clearly based on the case with radiating pain to the upper extremity. Anterolateral approach is made usually on the contralateral site of symptomatic lesion. An intradiscal tunnel is made through anterior annulus toward the foraminal or posterior lesion using punch, disc rongeur, forceps, curette and drill. Particularly, in case of drilling the greatest care should be taken not to press but only slightly contact on the lesion. Posterior longitudinal ligament should be removed and dura was exposed to confirm whereabouts of fragmented sequestered material. Only minimally invasive removal of lesion is made. None of bone dowel, metal or their substitute is replaced into the disc space.

Results : Surprisingly enough postoperative recovery was almost complete. Only 3 cases of foraminal stenotic patient showed delayed recovery for 3 months. One third of patients showed the slightest anterior angulation without symptom.

Discussion : Snyder reported fractional simple discectomy only on the soft disc herniation. However, microsurgical technique can overcome this limitation. Foraminal stenosis, osteophyte and hard disc are also sufficiently treated.

Conclusion : Drill-tunnel removal of cervical foraminal or posterior lesion is a safe and effective surgical method. In this case, replacement of material is not required. ◆

Endoscopic minimal open transtubular interlaminar decompression

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Study Design: Endoscopic technique for lumbar discectomy has been used by the author since 1993. The technique in single level spinal stenosis is described and the early results of 30 patients are presented

Material and Methods: The device (Endospine, Karl Storz GmbH, Tuttlingen, Germany) is composed of three tubes: one for the endoscope, one for suction and the largest one for classical surgical instruments. Since 1998 this technique has been used for spinal stenosis. Through an unilateral approach, bilateral decompression is performed. Thirty patients have been operated on from May 1998 to August 2001. Prolo's criteria were used.

Results: 27 patients (90%) presented an excellent result with only one complication (dural tear). The other patients (3) had a partial relief of pain and underwent a second operation (one disc prolapse and two contralateral persistent stenosis. One of them had already been reoperated because of a wrong level approach

and hematoma.

Conclusions: This technique is an efficient way to treat single level spinal stenosis even there is an associated spondylolisthesis (25%). In spite of a rather short follow-up, the good results and the satisfaction of the patients are a great advantage of this mini-invasive technique. ◆

Percutaneous laser disc decompression at cervical level

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STUDY DESIGN : prospective study concerning 29 cases with cervical disc herniations was evaluated 3 months after PLDD.

OBJECTIVES : To describe the technique and to evaluate the efficacy and safety of the Holmium YAG laser (LISA), in a population suffering from a radiculopathy secondary to a soft cervical herniation.

This study excluded sequestered fragments and important degenerative changes.

SUMMARY OF BACKGROUND DATA : PLDD was first initiated by CHOY and ASCHER in 1986 using a Nd:YAG laser at lumbar level. In Europe, the first cervical level case was performed by J.HELLINGER in 1991. In 1993, W.SIEBERT published a very large study in SPINE, establishing the codification of the technique at the different levels of the spine. He concluded that HO:YAG laser is safer and more efficient, giving its best results at the cervical level.

METHOD : A prospective assessment of 29 patients was performed at 3 months after the PLDD. The outcome was graded with an A.V.S. separately for the radicular and cervical pain. We also graded the degree of the patient's satisfaction by recording the excellent, very good and good results as a success, and the fair, poor and bad results as a failure.

RESULTS : At 3 months post-operatively we noted that:

- The neurological signs had totally disappeared.
- The average of the radicular pain was reduced by 77% on the AVS and the cervical pain by 57%.
- 72% of the patients (21/29) considered the result as a success.

The statistical analysis using the Signed Rank test was very significant ($p < 10^{-4}$). The patients operated with this technique had significantly improved at 3 months post-operatively.

No major complications appeared in this study except a local infection in our first case (no antibioprophyllaxis) and neurological symptoms in another case, 6 weeks after PLDD. Both patients were operated with good final result.

CONCLUSION : The preliminary results of this prospective controlled study are encouraging. The statistical analysis showed a significant improvement at 3 months post-operatively. This technique seems to be an interesting alternative to open surgery, being less invasive. However, correct selection of patients is most important and the operator must be well trained to PLDD techniques. The last generation of HO:YAG laser has made a real progress with regards to security.

The pain provocation during discography seems to have a prognostic value related to the good results.◆

Quo vadis ozonotherapy ? ab bibliographic review

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Non-invasive treatments are the first choice in most of the cases of lumbar disc herniation treatment. When this attempt fails to be effective, a wide number of minimally invasive treatments are now available such as laser or endoscopic discectomy, IDET and others. These techniques offer good clinical results with a well balanced cost and efficiency procedure. However, last studies report as much as 20% treatment failure rate with a failed back surgery syndrome in around 15% of them.

A reduction in herniated disc volume is the aim of any of these treatments in order to reduce nerve root compression. Percutaneous injection techniques such as pharmacologic discolysis are other treatment options and have shown good results. Recently, oxygen ozone therapy has become a new option of treatment for the lumbar disc herniation. Literature shows good results of ozone therapy in the treatment of different medical conditions but very few are written regarding the treatment of lumbar conditions. A bibliographic review was made in order to establish how many of the papers published have the minimal scientific evidence criteria and why this technique has reached to so much popularity in some areas of Europe.

To try to confirm this evidence we have started an experimental and clinical study. Histopathological changes are being studied after intradiscal injection of different substances (air, contrast and ozone) in healthy lambs, previously damaged lumbar discs, sacrificed within the 3rd and 6th week after injection. Simultaneously, a randomized double-blinded clinical study comparing intradiscal oxygen ozone therapy to intradiscal laser discectomy and chemical discolysis with alcohol is being done. ◆

Unilateral microdecompression for lumbar spinal canal stenosis

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The purpose of this report is to present a method of microscopic decompression of dural sac through unilateral approach in patients with lumbar spinal canal stenosis. Indications : The patient who had following conditions was selected.

1. A main clinical symptom is cauda equina intermittent claudication
2. A main pathology showed by neuroradiological studies is dural compression by hypertrophied yellow ligaments.
3. Symptoms related to an unstable spine are mild.
4. Over 3 months conservative therapy failed to improve the claudication.

Methods :A 2-3 cm posterior midline incision is enough to perform microscopic decompression. The one side of paraspinal muscle was divided by finger after cutting fascia. The operation field was maintained by special retractor. A lateral half of spinal process was removed to obtain clear visualization. A deformed and hypertrophied inferior facet was reamed to be paper-thin with surgical air tome. Hypertrope yellow ligament that compressed dural sac was released at its laminar attachments. Detaching yellow ligament from the lamina at one stage enabled us a safe decompression to neural tissue. We retracted dural sac medially to observe the disc. To observe opposite side of spinal canal, light axis of the microscope was changed. It was possible to remove yellow ligaments of opposite side by using microscope.

Postoperative management: We allowed patient to walk the next day of the operation. Patient was discharged after checking of neurological findings, lumbar plain X-ray and blood analysis.

Patients : We performed unilateral approach microscopic decompression in 190 patients with lumbar spinal canal stenosis from October 1, 2002 to April 30, 2004 We directly followed 142 patients at least 6 months (1.2 years in average). There were 59 females and 83 males.

Results :There were 7 dural tears. These complications occurred in cases before introducing the advanced method; one stage yellow ligament resection. The postoperative hospital stay was from 2 days to 14 days and 8 days in average. Postoperative results were evaluated with JOA score. Preoperative 14.1 points of JOA score was improved to 20.4 points postoperatively. Intermittent claudication improved in 89% of patients and low back pain improved in 75%. However, numbness in foot improved in 53%. An X-ray lumbar instability was preoperatively identified in 99 (69.7%) patients. There was no significant difference in postoperative results between patients who showed X-ray instability and no instability.

Conclusion : We should perform spinal surgery to an elderly patients as minimally as possible. A unilateral microdecompression with one stage resection of yellow ligaments enabled us a safe decompression to dural tube. This technique may indicate for elder patient with X-ray lumbar instability. ♦

Intravertebral fracture reduction: kyphoplasty/vertebral stenting under preload in vitro

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Fracture Reduction by Kyphoplasty remains often incomplete, due to a recurrent collapse of the vertebral body after removal of the balloon before filling the void created by the procedure. Introducing a stent to keep the result after balloon removal was thought to keep the reduction, especially when tested and performed under preload.

Material and Method: Human lumbar vertebral bodies were harvested from 8 different donors, dissected from surrounding tissue and BMD as well and geometrical parameters of the vertebral height were measured using CTscans. Then, an artificial fracture was produced by axial compression. For each group, 6 vertebrae were taken into testing. Under a preload of 110 N, in group A, Kyphoplasty without filling was performed, whereas in group B the Vertebral Stenting procedure was used. In both groups, the balloons were removed and the vertebral bodies were watched during a period of 3 minutes under the applied load.

Results: In the Kyphoplasty group, after initial reduction, all vertebral bodies collapsed to the height before the procedure. In the Vertebral Stenting group, the vertebral bodies kept 50% of the height gained by the procedure even after removal of the balloon.

Conclusions: By using an intravertebral stent, the problem of recollapsing and loss of reduction can be diminished. ♦

Stabilization of the spine in extreme osteoporosis

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Introduction: The increasing number of elderly people is related with an increasing incidence of osteoporosis as well as spinal canal stenosis and / or spinal deformity. Surgical treatment can be challenging as soon as internal fixation is required. Recommendation for these situations is the use of long distant fixation with multiple sites of anchoring, the acceptance of a lesser degree of deformity correction and the use of external bracing. The combination of cement reinforcement and internal fixation allows the application of the principles of internal fixation for normal bone also to the osteoporotic spine.

Patients/surgical technique : 21 Patients (av. age 69y, 10 f, 11 m) with documented severe osteoporosis and unstable vertebral fractures with consecutive spinal stenosis and / or severe kyphotic deformity of the thoracic or lumbar spine were reviewed (av. 14 months) after undergoing open decompression / correction and internal fixation with cemented screw fixation and cementing of adjacent vertebrae. The surgical technique consists in an open procedure with deformity correction and internal fixation. In order to achieve satisfactory screw purchase the vertebrae are reinforced with PMMA after preparation of the screw hole. The pedicle screws are then inserted and after curing the stabilization is completed. In a second procedure the adjacent vertebrae are reinforced percutaneously in a classical manner in local anaesthesia.

Results: The initial symptoms were a radicular pain in 5 patients, claudicatio in 13 and 3 patients with a weakness. Fixation was performed over 2 to 4 motion segments. Initial failure due to fractures of adjacent vertebrae occurred in 5 patients (none had prophylactic augmentation of the adjacent vertebrae). Finally in all patients it was possible to achieve a stable fixation with maintenance of the correction. Clinically the patients had all resolution of the neurological symptoms.

Discussion: The combined approach with cemented screw fixation and prophylactic reinforcement of the adjacent vertebrae seems a reliable technique for the treatment of this difficult cases. Based on the initial experience the risk for fracturing the adjacent vertebrae is high. Therefore the prophylactic reinforcement of the adjacent levels seems mandatory. The patients can profit from a limited intervention with less morbidity and preserved function due to the limited length of fixation. ♦

Percutaneous vertebroplasty for aggressive lumbar

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Vertebral hemangiomas are recorded in about 12% of the population (G. Schmorl and H. Junghanns, 1932). A surgical interest is shown in so-called aggressive vertebral hemangiomas (AG) being potentially hazardous by compression fractures of damaged vertebral bodies, epidural spreading of soft-tissue tumor component, extradural hemorrhages and medullar ischemia due to steal syndrome. AG make up to 3-4% of vertebral hemangiomas. With the low relative incidence of AG (0.48%), their number in absolute values for a Ukrainian population exceeds 25000 cases. According to our data, the ratio for AG in thoracic/lumbar/cervical/sacrum = 76:21:2:1 in 100 cases. We performed a percutaneous vertebroplasty in 28 patients with aggressive lumbar hemangiomas of cavernous (24) and capillary-cavernous (4) types. Female 18, male 10. Total variant of AG was revealed in 10 cases, body variant in 10, posterior variant in 2, anterior and posterior variants in 3 and the epidural variant 3 cases. The ratio of levels in the lumbar spine: L5/L4/L3/L2/L1 = 3:5:11:4:5 of 28 cases. Criteria of aggressivity : Absolute: increasing of tumor (under CT control), total variant or body variant of neoplasm involving more than 50% of the vertebral body, compressive fracture, epidural component, data of MRI-spectroscopy. Relative: total variant or body variant of neoplasm involving 30% - 50% of the vertebral body. Contradictory: involving of vertebral pedicle. Factors which make hemangiomas aggressive: trauma - 4, pregnancy - 3, unestablished - 21. Diagnosis: A major clinical manifestation of AG was the increasing local pain relative to localization of AG, which was further enhanced during physical workload. MR-spectroscopy is the key method for early determination of hemangiomas aggressivity. Of a lesser diagnostic value is the dynamic CT-control. Surgery : Percutaneous vertebroplasty (PV) is a method of choice for aggressive cavernous and capillary-cavernous types. Indications: gradual progression of clinical and roentgenological symptoms with the signs of hemangiomas aggressivity (MRI- spectroscopy data). Contraindications: epidural spreading of neoplasm with neurological signs, compression fracture more than 70% of vertebral body as a local skin infection, inflammation reaction of the blood and severe somatic problems. Surgical approaches: transpeduncular (25) and postero-lateral (3). One-side approach hemangioma less than 60% of the vertebral body, two-sided approach - hemangioma more than 60% of the vertebral body Surgical aspects: jerk-knee patient position, local anesthesia, intraoperative fluoroscopic control, venospondylography. Positive effects of PV: mini-invasive, come and go procedure; preventing fracture of the vertebral body, cytotoxic and hyperthermic influence on tumor. Results: No complications. A 3-year follow-up of 24 patients has not revealed any clinical or CT signs of disease progression. Conclusions : 1) Percutaneous vertebroplasty is an effective and minimally invasive method for AG. 2) Percutaneous vertebroplasty is a method of choice for AG. 3) MR-spectroscopy is a key method for early hemangioma aggressivity assessment. ◆

Kyphoplasty using the sky bone expander system: our experience in 118 cases

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Purpose: Recently, a novel kyphoplasty device for the reconstruction and creation of voids in vertebrae was introduced. It is the authors' intent to provide clinical data on the outcomes attained with this device.

Methods and Materials: The SKy Bone Expander System is a 4mm in diameter polymer tube that following axial pressure, radially expands up to 16mm in diameter. The concept enables percutaneous positioning of the device in its reduced form under local or general anesthesia, and its contraction and removal once vertebral reconstruction is achieved. The device creates a defined cavity, which enables paste-like bone cement injection instead of liquiform injection with standard vertebroplasty techniques. Several implant sizes are available. One hundred eighteen patients (33 males and 85 females with a mean age of 63.6) have been treated using this system. Of the one hundred eighteen treated fractures, 45 were fresh (less than 1 month), 50 were semi-fresh (1-3 months) and 23 were chronic (3-16 months). Eighty-two fractures were osteoporotic and thirty-six fractures were traumatic ones. Post-operative clinical evaluations were performed one week and at one, three and six months post-op.

Results: The anterior wall height ratio compared with that of the superior adjacent vertebra, was 41 percent pre-op, improving to an average of 83 percent at final follow-up. Average kyphosis angle decreased from 28 degrees to 9 degrees. VAS dropped from an average of 7.5 pre-op to 2.1 at final follow-up. Post-op CT revealed cement

leakage in three cases without clinical implications. All patients reported significant pain relief immediately post-operatively.

Conclusion: Kyphoplasty using the SKy Bone Expander system appears to be a simple, effective and safe mode of treatment of vertebral compression fractures at the author's hands. The device enables maximal control of the expansion stage and location. The cavity enables paste-like safe bone cement injection. ◆

Sunflower Kyphoplasty : a new restoration method for vertebral compression fracture

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Background : Traditional balloon kyphoplasty has a serial complex procedures, including entering a guide pin, placing a stylet and cannula over the guide pin, a hand-driven drilling to create a large channel, inserting bone tamp, and inflating the balloon, to make the void. To find a convenient and manageable method for the restoration of compressed vertebrae, we designed a new simple tool, Sunflower Kyphoplasty, using restoration power of the metal instead of inflatable bone tamp.

Methods : To reduce time-spending complex procedures making the void and to reduce the pain during creating a large channel, we made a one step access portal with 10-gauge cannula biopsy needle, which was much smaller than 8-gauge cannula balloon traditional kyphoplasty working channel. To reduce cost, we made a four-ala stainless steel instead of the inflating balloon to make the void. Lastly, to evaluate the restoration, we measured the average anterior, middle and posterior body height over 10 patients before and after treatment fracture pain within 3 months and the volume of cement injected.

Results : By using unipedicular approach, the mean operation time is 22.5 ± 5.6 minutes, pain during the procedure was tolerable under the local anesthesia with 30 mg of intravenous ketorolac, and height gain was 17 ± 7 , 15 ± 5 , and $14 \pm 3\%$ of predicted average anterior, middle and posterior height. The mean volume of injected cement was 4.3 ± 0.6 ml.

Conclusion : Compared with traditional kyphoplasty with a large working cannula and expensive balloon, a new method, Sunflower Kyphoplasty, is less painful and time-sparing procedure during making the void. The volume of injected cement and height restoration give us satisfaction. ◆

Is the sublaminar cabling safe and does it minimize the invasion of surgeries?

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Introduction: Intact neural arch is the most rigid posterior element, and failed in tension more than 3 fold compared with transverse process and spinous process. Sublaminar wiring was used for correcting spinal deformities and stabilizing the spinal column. This technique is not new, but became a major surgical method after Luque and Cardoso refined the technique. In the early stage, rigid stainless wire was used for catching the lamina followed by twisted wire cable. The twisted wire cable was easy to handle than the rigid wire, but is not used nowadays because of tendency to become circle-shaped lead to bow in the spinal canal and compression to the neural tissue can happen even after bone fusion. Nowadays the high molecular weight polyethylene cable can be used clinically in order to get additional stability and even in place of pedicle screws and hooks. The tensile and fatigue force of the cable does not give way to stainless cable and wire (Dickman). But influence by the high molecular weight polyethylene cable in the spinal canal is not well known.

Materials and Methods: Under L6 laminae of white rabbits polyethylene cable was passed and tied using tightening-gun. Inflammation-positive cells and cross sectional areas were checked after 12 weeks of sublaminar cabling.

Results: Macrophages and cells of positive cathepsin K were observed in specimens of 4 weeks, but were diminished in specimens of 12 weeks after sublaminar cabling. Cell infiltration between cables was lightly observed, but the cross sectional area did not hypertrophied in specimens of 12 weeks compared with 1 day after sublaminar cabling.

Conclusions: The high molecular weight polyethylene cable can be used for surgeries with minimum influences in the spinal canal. Because of easy handling and good conformance it can be used with less invasion for spinal surgeries. ◆

The role of B-Twin in different lumbar spine pathologies

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Among our overall serie of over 200 cases treated with a less invasive lumbar restabilization, using the B-Twin IVH System, we are at the point to clearly identify the primary indications for this technique. Besides specific degenerative lumbar spine conditions that can be included under the concept of lumbar segmental insufficiency, our protocol and technique has also achieved good to excellent results as stand-alone procedure for listhesis cases till grade II and as part of a single stage surgical treatment for spinal canal stenosis. Based on case examples we will expose our results and a patient tailored indications protocol. New technical aids for the percutaneous placement, such as a spinal robot, will be briefly presented as possible novel improvement. ◆

Mini-open anterior lumbar interbody fusion (ALIF) for recurrent lumbar disc herniation: minimum 2-year follow-up

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Many studies have been reported regarding the clinical outcome after treatment for recurrent lumbar disc herniation. However, the majority of data in the literature has dealt with the posterior approach with or without fusion of the affected segment and there have been few published articles describing the clinical outcome after ALIF for recurrent lumbar disc herniation.

Object. Recent advances in minimal invasive techniques have generated a great deal of interest in the ALIF procedure and have had spine surgeons consider it as being less invasive than the posterior fusion techniques. The authors conducted a retrospective review to determine the availability of mini-open anterior lumbar interbody fusion (ALIF) in selected patients who presented with recurrent lumbar disc herniation.

Methods. Patients with a recurrent disc herniation in the lumbar spine, having intractable pain of more than 8 weeks' duration refractory to conservative treatment, were considered for the procedure. A total of 22 patients who underwent ALIF have been followed up clinically and radiographically. The subjects were 11 men and 11 women, with a mean age of 46 years, ranging from 23 to 60, at the time of ALIF. The mean follow-up duration was 35 months, ranging from 30 months to 42 months. The Oswestry Disability Index (ODI) was used to evaluate the postoperative clinical outcome and patient satisfaction was also assessed.

Results. The average preparation time was 25.7 minutes (range, 15-45 minutes) and the average procedure time was 76.5 minutes (range, 50-110 minutes). The average estimated blood loss was 157 ml (range, 50 to 600 ml). The average length of hospital stay was 5.5 days (range, 4-10 days). Postoperative ODI revealed a marked clinical improvement following ALIF. The mean preoperative ODI was $64.9 \pm 13.1\%$. At postsurgery one month and the last follow-up, the mean ODI decreased to $24.6 \pm 9.4\%$ and $17.5 \pm 8.4\%$, respectively, and the Wilcoxon Signed Ranks test could find a statistically significant difference ($p < 0.001$). Twenty of 22 patients (90%) stated that they would undergo the same surgery for the same outcome (Patient Satisfaction Index of 4 or 5) and two patients selected category 3 (Patient Satisfaction Index, 3). On the basis of the criteria for determining fusion, the fusion was found to be solid in all patients. There were no complications related to the approach, discectomy, and cage placement.

Conclusions. The authors found ALIF to be an effective procedure with satisfactory clinical results in selected patients with a recurrent disc herniation in the lumbar spine. It seems that ALIF can be an alternative in the treatment of recurrent lumbar disc herniation. ◆

CT-controlled minimally invasive interventions: 7 years of experience

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The idea of CT-controlled biopsy suggested by D.Hardy et al. in 1980 has been realized in the evolutionary process in different practical applications in Magnitogorsk Center of dorsopathy, Russia:

- endoscopic nucleotomy of low lumbar discs under CT control (410 pts);
- laser decompression of intervertebral discs in lumbar and cervical spine under CT control (1300 pts);
- CT-controlled blocks of spinal nerves for diagnostics and treatment in cervical and lumbar spine (1600 pts);
- CT-controlled blocks and denervation in the presence of facet spine syndrome (710 pts);
- CT-controlled biopsy of pathological spinal formations (62 pts).

Some aspects of CT control in minimal spinal procedures have remained unsolved up to now:

- what specialists should be included in the group to set up indications to minimally invasive procedures and their performance?

-what instrumentation is necessary under certain circumstances?

- what navigation technique should be preferred?

In our opinion CT control has the following advantages:

- possibility of 3D images;
- image support in an axial plane;
- higher and more precise diagnostic information in comparison with ultra sound and X-ray control.

Disadvantages of CT control are:

- lack of real time mode;
- presence of artifacts with high density;
- impossibility of conclusive interpretation of CT image under movements, requiring delay of respiration under CT control;
- radiation load on the patient.

Conclusion:

- minimal invasive procedures under CT control are more beneficial and safer in diagnostics and treatment of patients with pathological spine;
- CT control expands the range of surgical aid in spinal pathology. ◆

Mathematical model of stability of a backbone in spinal surgery

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The account of dynamic loadings for elements backbone of a pole for a long time involves attention of the researchers of various specialities, since it directly is connected to the decision of the important medical tasks, namely, optimization of methods of treatment astable damages of a backbone and back brain. The set of works is devoted to this theme in the field of the Biomechanics, Neurosurgery and Orthopedics. For optimization of the standards of stability of a backbone the mathematical model three elements of a backbone a complex was created. In a basis of a technique the mathematical description of dynamic processes by the differential equations Lagrange 2 sorts made on the basis of the settlement circuit three elements of a backbone a complex is necessary submitted as the discrete concentrated weights connected elastic - springing elements. The created model allows expecting loadings for each of basic complexes in concrete cases of their defeats and optimum to solve the problem their stabilization. The method of mathematical modeling of stability of a backbone was applied at a choice of methods of operative treatment 72 patients c by astable damages of a backbone, which were operate in the period with 1997 on 2004. The average age was 35,9 years, thus of the persons of a male was 45, women 27. With damage in Neck of a backbone were 24, Thoracic 13, Lumbar 35 injureds. Study of the nearest and remote results of operative treatment has allowed making the following preliminary conclusions.

- The choice of surgical treatment of astable damages of a backbone depends on a level of a defeat, such as instability, degree spinal stenosis.

-The mathematical modeling allows more precisely defining a necessary type a design in each concrete case -
The mathematical modeling oh each case of instability allow to apply minimally invasive interventions at installation of a design. ◆

Cage fixing elements analysis and symmetry of the pyramids

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At present microdiscectomy, which designed more than 25 years ago, has become the gold standard in surgical treatment of patients with severe lumbar osteochondrosis. But, in spite of this, it permanently progresses (endoscopic videomonitoring, different types of the PLIF and transpedicular fixation).

In many respects, the stabilizing cage properties at PLIF depend on geometry of its bearing surface area, which interacting with the locking plates of interfacing vertebrae. The bearing surfaces are supplied with the different cogs' shape and size for maintenance of a durable contact with locking plates by an intrusion in them in the majority of modern cage models. There is a necessity in the task solution with antilogous criteria at synthesis of cogs' shape, because the increasing of a cage contact reliability with a plate results in increasing of destructiveness the last, that can result in to inconvertible loss of strength of bone tissue of vertebra body.

We studied mode of deformation of units of spinal motor segments by the final elements method for the analysis of stabilizing properties of wedge and pyramidal cages' cogs. The three-dimensional models of units with cages, which have different cogs' versions on supporting faces, were constructed in the Mechanical Desktop environment, and their final elements analysis was made in the Cosmos Design Star 4 environment.

In the range of accuracy of studied models, it is established, using of pyramidal cogs' shape in cages promotes localization of pressures and deformations in locking plates of adjacent vertebrae at their intrusion, not reducing restabilizing properties in comparison with cages, which have the wedge cogs' shape. We suppose, this fact is nonrandom and is conditioned by the laws of high non-Euclidean symmetries, which appropriate to the pyramids as geometric objects.

The pyramids have steady and energy "comfortable" shape, being one of the most perfect geometrical objects, which observed in the nature. Such shape has harmony, which is based on a principle of "golden section" and is unique from the different points of view: mathematical, technical, philosophical etc. For example, the unique properties of famous egyptian pyramids are known. It is possible to consider optimal the voltage distribution on cogs' surfaces in case of pyramidal cogs using in cages in concordance with different performance criterions and to accept as solution of the multicriteria problem referred above. ◆

A novel minimally invasive access technique for stand-alone lumbar interbody fusion in spondylolisthesis: Preliminary 13 month results on the deployable Optimesh graft device

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OBJECTIVE : Optimesh is a novel deployable interbody device used here for lumbar interbody fusion in spondylolisthesis by a minimally invasive access technique. It is inserted through a small fixed 8mm cannula and expands in situ when filled with allograft. Through this small portal, the Optimesh system minimizes the degree of extensive facet removal and neural retraction typically required for the exchange of working tools and for the insertion of fixed cages in posterior interbody procedures. The purpose of this study is to characterize the preliminary experience with the Optimesh device for in situ interbody fusion in the treatment of lumbar spondylolisthesis.

METHODS : 18 patients from 33 to 76 years of age (average 58 years), 10 female and 8 male, with lumbar spondylolisthesis at L3-4, L4-5, or L5-S1 with low back pain or radiculopathy were treated with minimally invasive decompression and interbody fusion with the Optimesh device. Postoperative follow-up ranged from 8 months to 24 months with an average of 13 months. Data was collected through personal interview, clinical examination, radiographic analysis, and medical record review.

OUTCOME MEASURES : Patients were interviewed, by an external doctor, for subjective assessments of level of function, time for return to activity, satisfaction with outcomes, and level of pain using the Visual Analog Scale. Surgical data was collected, including operative time and blood loss. Radiographic measurements for deformity, instability and fusion were employed.

RESULTS: Of 18 patients, 13 had stand-alone one level fusions with the Optimesh device, 3 of which also had an interspinous device placed in the superior adjacent motion segment. There were 2 stand-alone two level fusions, 2 one level fusions with bilateral pedicle screw instrumentation, and a one level fusion with unilateral pedicle screw instrumentation. Operative times ranged from 110 to 240 minutes with a mean of 177 minutes. Blood loss was less than 100cc in all cases. Additional levels of interbody fusion without instrumentation required an average of 13 minutes per level. There were no durotomies, neural injuries, transient or permanent paresthesias. No blood transfusions were required. There were two superficial wound infections which resolved with irrigation and debridement without removal of hardware, and a course of antibiotic therapy. Clinical follow-up revealed a preoperative Visual Analog Scale (possible 0 to 10) mean of 8.7, VAS mean of 2.7 the first week after surgery, some recurrence in 5/18 patients for a VAS mean of 3.7 at six months follow-up, and return to activity in a mean of 49 days (range of 10 to 240 days) in 17 of 18 patients. Mean hospital stay was 7.2 days with a range of 4 to 10 days, noting the lack of incentive for early discharge inherent in the reimbursement structure of the Italian health care system. Radiographic follow-up with X-ray, CT, and MRI showed the Optimesh engaged in between the vertebral body endplates in a lock-and-key type configuration, and no gross increase in spondylolisthesis. Stability was demonstrated with no evidence of movement of the involved segments on lumbar flexion/extension X-rays at 3 to 12 months follow-up. On average there was no decrease in interbody height postoperatively and no appreciable subsidence.

CONCLUSION : These preliminary 13 month results of the deployable Optimesh system used in lumbar interbody fusion for spondylolisthesis demonstrate that it appears to be viable as an interbody fusion device. There were no dural tears, cerebrospinal fluid leaks, or neural injuries in this series. This novel minimally invasive access technique paired with a unique deployable interbody graft device minimizes the risk of intraoperative complications related to surgical exposure and neural retraction associated with approaches employing fixed-sized interbody grafts and cages ◆

Experience and short term results with a new minimally invasive percutaneous fusion technique (SEXTANT/MEDTRONIC)

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Background: The traditional decompression and fusion techniques of the lumbar spine often need long skin incisions and excessive muscular detachment from bony insertions. This is believed to lead to unacceptable postoperative muscular insufficiency, adjacent level disease and postoperative LBP. Techniques to avoid these disadvantages of major spinal surgery include microsurgical operation, dynamic as opposed to rigid fusion systems, the use of stand alone cages and percutaneous as opposed to open fusion techniques. We therefore studied a recently introduced percutaneous transpedicular fixation technique (SEXTANT) in combination with microsurgical decompression techniques.

Methods: A total number of 44 patients has been treated from 01/2003 until 07/2004 (18 months), 15 females and 29 males. The age was between 34 and 85, the average age was 63.

The indication for operative treatment has been in 42 patients radiculopathy with at least one of the following radiological signs to treat: Instability (n=24), stenosis (26), dynamic stenosis (6), disc herniation (15), foraminal pathology (5), prior surgery (3), and in the 2 patients without radiculopathy we saw monosegmental Modic changes.

The operative treatment was first a microsurgical decompression of the stenosis on 1 or 2 levels, monolaterally or bilaterally from one side, with cross over decompression through a 3 to 5cm (one level) or a 6-8 cm two levels medial skin incision. - The second step was the placement of one or two interbody CONTACT fusion cages (SYNTHESE) from one side per level. - The third step was a percutaneous placement of four or six transpedicular titanium screws and titanium rods with the SEXTANT system (MEDTRONIC).

The patient assessment was performed by NAS pain scale, Roland Morris questionnaire and the MacNab criteria. The first follow up was from 32-109 days, average 52d (n=44). The last follow up was 78-460 days, average 214 d (n=41)

Results: At the first follow up (n=44): MacNab criteria for back pain/leg pain were as follows: Excellent and good results in (MacNab 1+2) 57%/70%. Improvement (MacNab 3) was observed 32%/23%. No improvement

(MacNab 4+5) was seen in 11%/7%. This means that we obtained a success rate (MacNab 1-3) of 89%/93%, corresponding to a failure rate (MacNab 4+5) of 11%/7% for back and leg pain respectively.

At the last follow up n=41: MacNab criteria for back pain/leg pain were as follows: Excellent and good results (MacNab 1+2) in 68%/84%. Improvement (MacNab 3) was observed 22%/14%. No improvement MacNab 4+5) was seen in 11%/3%. This means that we obtained a success rate (MacNab 1-3) of 89%/97%, corresponding to a failure rate (MacNab 4+5) of 11%/3% for back and leg pain respectively.

We encountered 3 complications that needed percutaneous reoperation for postoperative radiculopathy: One posterior cage dislocation, one contralateral foraminal root compression by a bulging disc and one compressive and irritating wrong screw placement. We encountered no bleeding, no infection, no CSF leakage. No conversion to open surgery has been necessary.

Operation time for monolevel and bilateral decompression and cage fusion (n=36) was 2,8 h, (1,7h-4.6h)

Surgical time for bilevel bilateral decompression and cage fusion (n=8) was 3,9h (3,0h-4,4h)

Hospital stay (n=44) was 13 days (8-25 days).

Additional postacute rehab was indicated in 15 and not necessary in 29 of the 44 patients

Conclusions: The SEXTANT fusion procedure is technically demanding and time consuming. But the absence of surgical complications such as infection, bleeding and CSF leakage, as well as the surprising low failure rate may be attributed to the low impact surgical procedure namely short skin incisions, microsurgical decompression, microsurgical cage insertion and the percutaneous screw and rod implantation.

It remains to be demonstrated that this minimal invasive technique also reduces the incidence of adjacent motion segment disease. ♦

Percutaneous lumbar stabilization: an advantage in comparison with traditional approaches

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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). 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 October 2004. 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 90 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. ♦

MOBILITY OF DYNAMIC NEUTRALIZATION SYSTEMS FOR THE LUMBAR SPINE

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INTRODUCTION : The main objectives for dynamic stabilization of the spine are to restore disc height and normal kinematics as well as to minimise stress on the adjacent segment by maintaining the segmental mobility. Posterior dynamic stabilization systems for the lumbar spine aim to address these requirements. Recent biomechanical studies have measured the remaining segmental motion when a posterior dynamic stabilization system is applied to the spine. A main interest in such studies is the determination of the stiffness or the range of motion (ROM) of the spine before and after the implantation of the device. The aim of this contribution is to review the available in vitro and in vivo data regarding parameters that influence the mobility when using Dynesys[®] as well as to investigate in how these measurements reflect the long term situation in the patient.

MATERIALS AND METHODS : Several in vitro studies compared DYNESYS[®] with the intact, the unstable and the fused spine respectively. In their cadaver experiment Schmölz et al. used six human lumbar spines applying pure moments with and without an axial follower type preload. Niosi et al. conducted a similar study, using ten human lumbar spines. This study also looked at the influence of various spacer lengths. Freudiger et al. used a muscle type loading apparatus in the sagittal plane [1]. In this study a muscle force type loading regimen was used applying relatively high loads. An in vivo study used Kirschner-wires implanted into the spinous processes of DYNESYS[®] patients under local anesthesia to measure three-dimensional motion.

Furthermore, a baboon model was used to measure kinematics immediately as well as 6 and 12 months after implantation [3].

RESULTS : Schmoelz et al. found that DYNESYS[®] restored motion after a destabilization to the amount of the intact spine in extension, whereas in flexion a substantial stabilization was found [2], similar to an internal fixator. For lateral bending a substantial stabilization effect was found. However, there was more motion with DYNESYS[®] than with the fixator. For axial rotation more motion was found with DYNESYS[®] than for the intact and the fixator condition. Similar results were found by Niosi et al. [5]. This study also found that an increased spacer length increased the mobility in the segment.

The application of an axial "follower" preload did not substantially change the findings. The muscleforce type loads by Freudiger resulted in a greater ROM for flexion and extension with DYNESYS[®] compared to Schmölz and Niosi.

The measurements of the three dimensional motion before and after a DYNESYS[®] operation in the human in vivo study showed a large variation among three patients. One patient demonstrated a significant increase in ROM for flexion-extension, whereas one showed no significant change and one showed a decrease in flexion and an increase in extension. The large ranges of motion found in some patients seem to contradict the biomechanical findings in vitro. In the in vivo study using baboons conducted by Cunningham et al., after 6 months the results showed a significant increase in motion compared to the acute (immediately post OP) state [3]. However, there was still a significant stabilization compared to the segmental motion without DYNESYSTM. Between 6 and 12 month, there was no significant increase in motion.

The observed relaxation phase in the in vivo animal model was also seen in fatigue testing of the device within the first two million cycles. In this phase the stiffness decreased about 30% in tension and 24% in compression. After two million cycles the stiffness of the device remained constant.

DISCUSSION : In vitro studies suggest that DYNESYS[®] stabilizes the spinal segments substantially in flexion and lateral bending, whereas in extension and axial rotation a range of motion around the in intact condition can be measured. In all loading directions, more motion was present with the DYNESYS[®] than for the internal fixator, except for flexion where it was not different [2].

For in vitro models, the applied load to the system seems to be crucial. Little information is available on physiological loads in a spinal segment. Rohlmann et al. measured the loading in a fixation device in vivo which gives some information about the load that is transferred through a posterior device but the exact amount of load which is carried by the remaining biological structures is still not known [4]. The greater ROM with the muscle type loading model may indicate that higher loads increase motion in flexion but not in extension. Although, for in vivo measurements the loading in the particular segments are not known, larger ROM can be seen in vivo than found in the in-vitro studies. The results found in the animal study provide additional information to the discrepancy noted between in-vitro (acute) and in-vivo (chronic) data found in the human investigations. Also the fact that the rigidity of a device can change over time has to be taken into account when performing in vitro tests. In general the in vitro situation represents an immediate post OP situation. It can be concluded that the differences seen between in vivo and in vitro ROM after DYNESYS[®] implantation may be due to fact that the applied loads during in vitro testing did not fully represent the physiological situation and/or the rigidity of the device changes predictably in vivo within the first six months which can also be observed during fatigue testing.

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Dynamic stabilization above fusion: the "hybrid" technique with Dynesys

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Introduction and purpose: Today the standard of care for many patients with advanced multisegmental degenerative disc disease (DDD) of the lumbar spine involves fusing spinal segments to eliminate painful motion. However, in addition to sacrificing mobility fusion has inherent disadvantages including increased invasiveness, adjacent segment deterioration and uncertain clinical outcome which may vary between 16% and 95% satisfactory outcome. In cases of multisegmental disease it is also often difficult to determine the levels to be fused. As different spinal levels frequently present with different stages of degeneration, it seems desirable to treat them with differentiated surgical procedures according to their status. The purpose of our clinical trial was to investigate, whether it is possible to combine a dynamic stabilization (DYNESYS) with a fusion procedure (PLIF) in the treatment of multisegmental DDD of the lumbar spine. **Methods:** Our prospective non-randomized study evaluated pre- and post-operative pain and function in a consecutive series of 32 patients (15m/17f), with a mean age of 50.3 years (26-76) at surgery. During the study period we had to exclude one female patient due to cancer disease. Main indication was DDD, frequently combined with failed low back surgery syndrome or stenosis. All operations were performed by the first author between May 1997 and November 2002; the mean follow-up-time was 39 months (24-90). **Results:** Early postoperative complications occurred in 4 patients (one wound revision due to seroma, 2 urinary tract infections and one deep vein thrombosis). Detailed results about pain and function will be presented. Average Oswestry DI improved from 52% to 29%, with improvement in 29 patients. 19 patients (61%) showed an improvement of ODI of more than 15%. At latest follow-up no further surgery had been necessary in this patient group. The radiological follow-up disclosed clear signs of a pseudarthrosis in one patient. In two patients we observed loosening of DYNESYS screws, in one case at the fusion level (pseudarthrosis), in the other case at a neutralization level. **Conclusion:** Segmental treatment of degenerative lumbar conditions with Dynesys in combination with a fusion procedure is technically feasible and yields a significant improvement in clinical outcome. Comparing with reported results in the literature the combination of a dynamic stabilization with a fusion procedure proves to be a good alternative to multisegmental lumbar fusion. ◆

Decompression and dynamic stabilization in degenerative Spondylolisthesis : 4 years follow-up

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In spinal stenosis with degenerative spondylolisthesis, decompression and fusion is widely recommended. However, patients suffer from donor site pain. A novel dynamic transpedicular system (Dynesys) was introduced to the market, stating that stabilization is possible without bone grafting.

Objective: To test whether elastic stabilization with Dynesys can maintain enough stability after decompression for spinal stenosis with spondylolisthesis.

Methods: 26 patients (mean age 71 years) with lumbar spinal stenosis and degenerative spondylolisthesis underwent interlaminar decompression and stabilization with Dynesys. Minimum follow-up time was 4 years. Operative data, clinical outcome, plain and functional radiographs were obtained and compared to pre- and postoperative data.

Results: A total of 22 patients could be evaluated (84%). Mean leg pain decreased significantly ($p < 0.01$) and mean walking distance improved significantly to more than 1000 meters ($p < 0.01$). Radiographically no significant progression of spondylolisthesis could be detected. Progressive degeneration of the adjacent segment was observed in 45%. The implant failure rate was 17%, none of them was clinically symptomatic.

Conclusions: In elderly patients suffering from spinal stenosis with degenerative spondylolisthesis dynamic stabilization with Dynesys* in addition to decompression leads to similar clinical results as seen in established protocols using decompression and fusion with pedicle screws. It maintains enough stability to prevent progression of spondylolisthesis. Using Dynesys, no bone grafting is necessary, therefore donor site morbidity can be avoided. ◆

Restabilization in lumbar spine with the semirigid ISOLOCK device:mid-term 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, semirigid stabilization techniques became more and more importance.

Material and Methods The IsolockR device contains top-loading pedicular screws, which are connected with special semirigid plates. These plates are laid between eccentric hemispheric washers, which guarantees another semi rigid element. In two years (2003-2004) we have been used this device in 56 patients (28 males and 28 females). In 28 cases two segments (L4 and L5) were instrumented, in 17 cases segment L5. Most patients ranged in the age-group 51-60 years (23), but 15 patients were getting between 31 and 40 years of age. Our patients can be categorized into 4 indicative groups: 1. lytic spondylolisthesis with intact disc, combined with posterolateral bone grafting, 2. degenerative deformities and spondylolisthesis, 3. disc degeneration combined with instability of the adjacent segment, 4. instability of the adjacent segment after previous surgery. In 9 cases PLIF technique (PROSPACE) were added, in 2 cases TLIF (TRAVIOS).

Results Patients were prospectively followed up. In none case the stabilization device has been failed. For clinical results, the VAS was used. In 21 patients the pain relief decreases to less than 50%, in 31 patients to less than 25%. **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.

Discussion : 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. Fluoroscopical results and pain descent in our semi rigid stabilized patients seem very encouraging. ◆

pMRI changes in discogenic low back pain after Dynesys or XStop application

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Part 1:

Patients treated for discogenic low back pain with Dynesys stabilisation system. Preliminary report (pMRI findings)

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The Dynesys device uses transpedicular screws linked by a cord and spacers. It is claimed that the advantage is that it allows some motion, in all directions, in the operative levels. In vitro laboratory biomechanical studies show that the movement permitted is similar to rigid fusions. This study measures the changes in the lumbar spine in different postures, pre- and after insertion of the device. Twenty patients with dominant low back pain, with or without leg pain, were treated with Dynesys system. Stress discography was made to evaluate the symptomatic level. All had a positional MRI preoperatively and nine months post-operatively in flexion-extension-lateral bending. The patients were divided into two groups: Group(A) with 8 patients in which Dynesys was used with fusion (disc-height < 40%) Group(B) with 12 patients was the Dynesys-only group (disc-height = 40-90%). There were 42 operated levels, 10 of those were fused. The results showed that there was a statistically significant reduction in flexion-extension range of movement of the whole lumbar spine (mean = -13.45) ($p < 0.005$) and at the instrumented segments was (mean = -4.06) ($p < 0.05$). There was no significant change in the level above (mean = 0.056) ($p = 0.972$). The anterior disc height was slightly reduced (mean = -1.18) ($p < 0.05$) and the posterior showed no change (mean = 0.37) ($p = 0.134$). In lateral bending, changes were (mean = -0.87) ($p = 0.18$) for left and (mean = -0.24) ($p = 0.75$) for the right.

DISCUSSION: This study shows that in the Dynesys stabilizing system allows small range of movement at the instrumented levels, with no significant increased mobility in the adjacent levels. Also the device acted to compress the anterior annulus

Part 2:

The positional MRI changes in the lumbar spine following insertion of a novel inter-spinous process distraction device

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Patients with symptomatic lumbar spinal stenosis underwent positional MRI (pMRI), to study changes in the lumbar spine in various postures before and after implantation of the XStop Interspinous Process Distraction Device. Previous studies have shown vertebral canal and exit foraminal area to reduce from flexion to extension. Using pMRI, patients were scanned before and six months after operation. Images were taken in sitting flexed, extended, neutral, and standing positions. The total range of motion of the lumbar spine and of the individual segments were measured, along with changes in disc height, areas of the exit foramina, and dural sac. In 12 patients with 17 distracted levels, the area of the dural sac at these levels increased from 77.8 mm² to 93.4 mm² postoperatively in the standing position ($p = 0.006$), with increase in the exit foramina, but no change in lumbar posture. This study demonstrates that the XStop device increases the cross-sectional area of the dural sac and exit foramina without causing changes in posture. ◆

TECHNICAL AND ANATOMICAL CONSIDERATIONS FOR THE PLACEMENT OF A POSTERIOR INTERSPINOUS STABILIZER

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INTRODUCTION : The behaviour of a FSU is related to the displacement of the center of reaction, making it possible to balance the moments and thus control the transferred loads. Weight bearing results in preloading of such prosthesis ; this, combined with posterior tension banding, provides restoration of local lordosis. Thus the

implant acts on the foraminal bony elements to change local conditions, reducing venous congestion & traction on the ganglion.

ANATOMOSURGICAL CONSIDERATIONS : Disrupting the musculature segmental damage the dynamic spinal stabilization & degrade the outcome. The midline muscle group in the back is the multifidus. A relatively robust pair of tendons originates from the caudal aspect of each spinous process. The plane along the spinous process and over the lamina, free of any attachments has to be respected not to compromise the neurovascular supply. The erector spinae is a broad flat tendon covering the back muscles. This tendon has a stout insertion developed at each level to the spinous process. Approaching the spine from an approach 10 mm or thereabouts from the midline allows preservation of the integrity of the erector spinae insertion while making an approach along the spinous process. Finally placing the device in a ventral location on the lamina with preservation of tendon dorsal preserves the natural dynamic stability of the spine and secure the device in its most appropriate location.

SURGICAL PROCEDURE : The most frequently involved level is L4-L5. The decompression of the nerve roots is highly recommended in the presence of positive symptoms. A distractor is used to spread the overlapping laminae. Then is applied retensioning of the supraspinous ligament, realignment of the facets and articular capsules. The folded implant is inserted and driven to the opposite side with a specific inserter.

INDICATIONS : The device is used to prevent the consequences of the overloading of the facets following a discectomy, or within lateral stenosis. Implantation of the device is associated with nerve root decompression. A retrolisthesis worsens the stenosis and requires its reduction. In cases of facet syndrome and black disc, the device is implanted at one or several levels to assist in unloading the disc and the posterior articular columns which are subjected to excessive loads due to the degenerative process. A block-test helps identify the source of pain. The toping-off indication addresses the adjacent segment after lumbar fusion in cases where decompression and/or instrumentation may compromise the adjacent facets.

BIOMECHANICS OF POSTERIOR DYNAMIC STABILIZING DEVICE : The effects of a posterior interspinous stabilizer has been analysed on biomechanical behavior of the lumbar spine after discectomy and partial facetectomy ; the clinical situations in which its use might be considered. A posterior dynamic stabilizing device is effective in reducing the increased segmental flexion-extension motion that is observed after a discectomy or partial facetectomy. These biomechanical effects must be considered when evaluating the clinical applications of such device.

CONCLUSION : A posterior interspinous stabilizer restores the vertical component of the posterior moment arm, which helps the reestablishment of the ligamentotaxis. Realignment of the facet interface restores the facet congruity. Distraction of the neural arch results in enlargement of the neural foramen, relieving neural compression. ◆

BIOMECHANICS, INDICATIONS AND CLINICAL RESULTS OF DIAM INTERSPINOUS DEVICE IMPLANTATION: 18 MONTHS FOLLOW-UP

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Objective: Indications for and treatment of the low back pain due to degenerative disc disease by application of interspinous dynamic distraction device - DIAM. Prospective non controlled case series.

Background: Although disputed as a diagnosis, the segmental instability due to degenerative disc disease seems to be at the origin of low back pain in a considerable number of patients. Various diagnostic measures like provocative discography, dynamic x-ray, MRI, corset wearing and similar were tested trying to establish the origin of the pain. Fusion of the involved vertebral segments seems to provide, in a relatively high percent of cases, relieve of symptoms and improvement in pain and function by relieving load pressure and stabilizing the segment.

Methods and Materials: Fifty patients, mean age 44.5 y (\pm 11.4), affected by low back pain due to degenerative disc disease were included in the study. The diagnosis of the patients was based upon four diagnostic measures: clinical examination positive for pain due to load increase, MRI positive for discopathy, dynamic x-rays positive for segmental instability and provocative discography positive for pain reproduction. Just those patients that had a concurrence of at least three out of four of these diagnostic measures were submitted to operation.

The patients were followed upon for pain by Visual Analogic Scale and for functional status by Roland-Morris Disability Questionnaire. Moreover, overall satisfaction with the treatment was tested by Overall Patient

Satisfaction Scale. The minimum follow-up was 18 months ranging from 18 to 30 months. The intermediate follow-up at six and twelve months was tested for, too.

Results: Two out of fifty patients did not gain improvement following the procedure. The rest of the patients improved significantly achieving a statistically significant improvement in pain (5.3) and function (9.3). Including all of the patients, the values for the VAS at time 0 was 6.6 improving to 1.3 on 18 months. The mean functional status at time 0 was 12.8 improving to 3.5 at 18 months. The Overall patient satisfaction with the treatment was 72.6% at 18 months.

No patient worsened upon surgery and there were no complications observed on short or long-term post-surgery period.

Conclusions: This non controlled prospective case series indicates that this newly developed less-invasive approach could possibly be useful in treating low back pain due to degenerative disc disease. Further research with RCT is necessary to confirm this preliminary results. ♦

Revision surgery in artificial disc replacement including case reports

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The increasing acceptance of total artificial disc replacements does not lead to satisfactory results only. An increasing number of specific complications is becoming apparent. The surgeon should know all important details about revision surgeries in the case of complications. The patient should have the possibility to ask the surgeon about the management of these complications.

There are early and late specific postoperative complications.

At first it is important to decide in each case whether an anterior or posterior approach to the lumbar spine is useful. It depends on different factors, such as the number of postoperative days, the level of prior surgery, the number of artificial discs, the general risk of surgery and others. In the case of a second anterior approach, the scar-tissue surrounding the ureter and the large vessels are the main risk in dissection. Personal experience shows that a modified anterior approach near to the transversus abdominus muscle should be taken into consideration.

In cases of subsidence of the total artificial disc and facet joint pain the implant can stay in place and function as a spacer. A dorsal instrumentation, if necessary in combination with an arthrodesis of the facet joints and/or neurolysis, is indicated. Up until the 10th to 12th postoperative day the decision to exchange the implant with a larger one can be made. If the patient does not have too much pain and can get along well without revision surgery, spontaneous segmental fusion follows in many cases.

If the patient has complaints caused by an insufficient placement of the prosthesis, especially at levels L3/4 and L5/S1, a change of the prosthesis or an anterior-posterior fusion could be planned. In preparation for surgery a local anaesthesia of the segmental facet joints can give information for the planned surgery. Revision surgery in cases with a long postoperative period is very difficult because of the abdominal scar-tissue.

Depending on the type of fixation of the plates (teeth or keel), lateral revision surgery is more or less indicated. Not speaking from personal experience until this time, an infection of the operated segment can be treated via a lateral approach at level L4/5 and above. ♦

Maverick total lumbar disc replacement. European Prospective study Preliminary report of 60 cases at 2 years follow up

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Introduction: The concept of accelerated degeneration of adjacent disc levels as a consequence of increased stress caused by interbody fusion of the lumbar spine has been widely postulated. Total disc arthroplasty may offer the same clinical benefits as fusion while providing motion that may protect the adjacent level discs from the abnormal and undue stresses associated with fusion.

Objectives: The goal of this study was to prospectively analyze the results of the Maverick Lumbar Disc Prosthesis (Medtronic, USA) at 2 years follow-up.

Methods: We conducted a prospective analysis of the Maverick Lumbar Disc Prosthesis implanted in the first 60 consecutive patients for the treatment of single-level degenerative disc disease of the lumbar spine resistant to conservative treatment for more than 1 year. The outcome data collected included the Oswestry Questionnaire and Visual Analog Scale (VAS) preoperatively and at routine scheduled followups. Radiographic analysis included sagittal balance parameters on standing full length lateral radiographs of the spine and range of motion on flexion/extension dynamic radiographs. 3 european centers were included in the study

RESULTS: There were 32 females and 28 males with an average age of 43, 4 years and average followup of 1,8 years (12 to 32 months). The Maverick prosthesis was implanted at L4-L5 level in 28 patients and at L5-S1 level in 32 patients. Clinical success, defined by the FDA as improvement of at least 25% on the Oswestry, was 76% and 81%, at 6 months and 1 year followup respectively. The VAS showed an improvement in back pain from 7.1 (+/- 2) pre-operatively to 3.0 (+/- 1.8) post-operatively. Leg pain was significantly higher according to VAS when patients have been previously operated for disc herniation. At 1 year, there was no measurable subsidence of the devices and no evidence of device migration. The measured range of motion in flexion-extension ranged from 3 to 16 degrees (mean range of motion, 6 +/- 4 degrees). L4-L5 level is more mobile: average 7,4 degrees. With regards to sagittal balance, there was no significant change in any of the variables studied including sacral tilt, pelvic tilt, or overall lordosis after placement of total disc arthroplasty. One complication, a ureter injury occurred during the approach in one procedure. One left iliac vein injury occurred per-operatively and treated with vascular clip. One patient with persistent low back was re-operated for posterior fusion with a significant improvement of pain at two years. This patient had been operated 3 times before for disc herniation and recurrence of HD.

CONCLUSION: These results of total disc arthroplasty compare favorably with the short-term clinical outcomes associated with anterior lumbar discectomy and fusion reported in the literature. Unlike fusion however, it appears that the prosthesis has enough freedom of motion to allow the patient to maintain the natural sagittal and spinopelvic balance with radiographic evidence of normal range of motion. However, these early favorable clinical results in addition to the influence on adjacent motion segments can be assessed only after long term follow-up.

◆

Non invasive assessment of spinal motion & posture in clinical practice - case reports

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INTRODUCTION: Most spinal surgeries are expected to lead to changes in functional behaviour of the spine. Therefore the measurement of posture and intersegmental mobility may be used in order to assess the outcome of surgery. In order to take advantage of good cost-benefit-ratio, noninvasiveness, absence of radiation as well as easy and fast documentation, measuring systems such as the Spinalmouse are used.

METHODS: Various spinal surgeries were carried out by different Swiss and German spine groups. The patient underwent X-ray procedure and non invasive posture and mobility measurements before and after surgery. Therefore the Spinalmouse was manually guided over the skin of the back along the spinal column while the measuring head followed automatically the sagittal and lateral shape. Clinically relevant parameters such as length, inclination relative to a vertical line, sagittal and lateral curvature, segmental angles of the thoracic and lumbar spine and pelvic tilt were registered.

RESULTS: The outcome assessment of minimal invasive spinal fusions as well as conventional spinal fusions using Spinalmouse data showed clearly reduced ranges of motion in the segmental levels concerned. In some cases the change in range of motion was found to be slightly above the level of intervention. This could either

be attributed to the fusion techniques adopted or to a slight systematic difference between x-ray and Spinalmouse measurement procedure.

CONCLUSION: The used system recorded with good reproducibility and clinical validity. The intersegmental range of motion values can be used in order to validate patients and their outcome after fusion surgery. The use of measuring systems such as the SpinalMouse can provide objective evaluation of the outcome of surgery.

The study was supported by the Clinical Research Group of OSSACUR Germany. Data has been provided by different Surgeons, a special thank to Dr. med. D. Werner, Germany. ♦

Objective control system of the physical state of the lumbar spine after endoscopic surgery (100 cases)

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From Dec. 2000 to June 2004 the author performed posterolateral endoscopic excisions of lumbar disc herniation, L1 to S1, on 100 consecutive patients. The general inclusion criteria for this study required clinical evidence of lumbar disc herniation and more than 3 months of failed conservative treatment, intractable leg or buttock pain, and/or functional impairments. The endoscopic inclusion criteria met the same indications as for open discectomy.

Disc protrusions without radiculopathy signs were excluded from this study. Lumbar sagittal and frontal Rx, MRI, blood analysis and ECG were standard performed. Under local anesthesia and light sedation 100 patients underwent provocation discography (positive discography level = contrast escapes or profiles herniation). The Discography exclusion criteria consisted of a normal disc shape. The transforaminal endoscopic procedure was performed only at the positive level.

The procedure was done like described by Yeung et al. (Spine Journal) using a 20° rigid endoscope with a working channel of 2,7 mm.; Laser Holmium-YAG 80 Watt with 90° side firing electrodes; radiofrequency coagulation system and indigo carmine to blue stain abnormal nucleus pulposus and annular fissure (Schreiber et al. 1989).

Every procedure was video-recorded for subsequent analysis and feedback learning purposes. Discography images were printed and added to the patient's documentation.

There were 65 (65%) male patients and 35 (35%) female patients, while the average male patient's age was 45,35 years and the average female patient's age was 42,9 years, within an age range that comprised 17 to 74 years. Patients were evaluated with a postop. clinical control of a minimum of 6 months. A group of 62 patients was controlled by an independent physiotherapist and underwent classical physiotherapy during 6 weeks. The other group, consisting of 38 patients, was controlled and measured using the FPZ method (isometric lumbar muscle force and lumbar mobility analysis). They underwent the FPZ system with the aim of reconditioning the muscular and articular spine motion system by doing muscular exercises with machines two times a week during 12 weeks.

The results of both groups are compared and discussed in this article. The final conclusion is that the FPZ system seems to provide better control and better final rehabilitation results during the rehabilitation period.

♦

Patient assessment and documentation in daily routine with questionnaires: necessary ?

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Aim: We wanted to analyze the concordance between the patients view of symptoms and the doctors view. The patients view was based on the answers in a validated questionnaire (NASS lumbar element) and the records in the charts. The concordance was analyzed for the main symptoms (back- buttock pain, leg pain, neurologic symptoms).

Methods: 44 consecutive patients with lumbar spinal stenosis were included in the study treated 2002. All patients had radiological documentation (native x-ray, MRI) and no response to conservative therapy over 6 months. At admission, 3 months and 12 months after the surgery the patients were examined by their doctor and

filled out a specific questionnaire (NASS, lumbar element). The doctor was blinded to the results in the questionnaires.

The symptoms (back and buttock pain, leg pain and neurology) were followed in the charts and in the questionnaires. The data were converted to qualitative data (symptom present or absent). Total agreement was for all three symptoms in the charts and questionnaire, partial for at least one symptom and none for no symptom.

Results: 44 patients (30 women/14 men) average age 63 years were included. Surgical treatment: 2 patients decompression, 38 patients decompression and stabilization and 4 patients stabilization. With intense symptoms total agreement was for 21 patients (48%) and partial for 23 patients (52%). With less intense symptoms total agreement was found in 10 patients (23%), partial agreement in 30 (68%) and none in 4 patients (9%). In most of the cases of no and partial agreement the patients reported more symptoms than the doctor in the charts.

Conclusion : Strong symptoms have a good agreement between the charts and the questionnaire, reduced symptoms have less agreement. There might be a tendency to document less symptoms in the charts compared to the answers in a questionnaire. The use of a simple questionnaire in daily routine may be helpful. ◆

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