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**Lumbar disc herniation – clinical aspects and operative treatments  
correlational dependencies**

Abstract

PhD neurosurgical thesis

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Varna 2020

This PhD thesis is completed on 133 pages; 69 figures and 48 tables included.

Literature cited – 179 titles

Disertation is realized as MU Pleven scientific project, affiliated by “Neurology and neurosurgery” Pleven and “Neurosurgery and ENT” Varna departments

There were 5 relevant publications

Investigations were carried out in the department of “Neurology and neurosurgery” - Pleven, UMBAL “G. Stranski”- Pleven and MBAL “Avis Medica”- Pleven

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To defend the thesis on 19.03.2021.

All materials are available at the scientific department of MU Varna

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## **Abbreviations used**

VAS - visual analogue scale.

ODI - Oswestry Disability Index (permanent functional disfunction/disability).

SPORT – meta analysis for spinal diseases.

MLSS - meta analysis for spinal diseases.

FBSS – failed back surgery syndrome.

PELD – percutaneous endoscopic discectomy.

MIS-TLIF – minimally invasive transforaminal fusion.

MED – microendoscopic discectomy.

EELD – endoscopic epidural laser decompression.

TELA – transforaminal endoscopic laser annuloplasty.

SOD – standard open discectomy.

MD – microscopic discectomy.

## **Introduction**

Herniation of the lumbar disc is quite common pathology in the young and middle aged people. The intervertebral disc is a complex structure of collagen, proteoglycans and sparsely populated fibrochondrocytes, which buffer the multiple loads of the vertically situated in the three dimensional space human spine. The aging spine discs produces less proteoglycans resulting in discal collapse, straining the annular fibrous ring that surrounds the pulpous nucleus. Some fissures and tears of the fibrous ring stand as “weak spots” and facilitate the pulpous nucleus herniation. External forces are mandatory in such cases. Even the “normal disc” is not able to withstand it. So discal protrusions and herniations invade the spinal canal. Lumbar and radicular pain is a consequence of some locally born inflamatiry factors that cause ischemia and neurochemical (aseptic) inflammation.

Treatment of this pathology naturally aims combating the radicular pain, motor and sensory disturbances and finally restoring working capacity.

When conservative treatment is unsatisfactory, operative (neurosurgical) treatment should be considered.

Clinical aspects of this pathology and correlational operative dependances are the goal of this investigation.

### **Literature data – conclusions**

The ODI criterion for SOD and MD outcomes showed excellent and good result in 91% of all cases. Reoperations performed – 10%; 15% at different level. 2% of all patients were subjected to third operation (8% after MD and 12% after SOD). Excellent clinical results were detected even 30 years after the original operation. We found considerable number of studies that emphasized on excellent clinical outcomes immediately after the operation.

The trial SPORT (4 years follow up) documented clinical advantages of the surgical treatment for LDH. This prospective randimized study concluded no VAS, ODI statistic differences for

the two investigated groups (conservatively and operatively treated). The effect after SOD and MD was better than chemonucleolysis with chemopapain.

Young patients (up to 17 years of age) were reported to experience 6 months follow up before eventual decision for operative treatment. It was recommended MRI Phirman grading system assessment of the young disc. 82% of young patients “accused” social and sporting traumatizing factors for their LDH diagnosis. Main symptom was low back pain.

During the 90-ies MRI became a decisive diagnostic tool for LDH. Conservative treatment for LDH, all along with thorough histology and immunohistochemistry data of the intervertebral disc, revealed new knowledge in the direction of reducing the herniated volume to its “disappearance” in the course of several months.

Intradiscal application of O2-O3 gained supporters during the last 15 years. Macnaab, VAS and ODI criteria stated clinical success in 75-80 of the “soft herniation” cases, 70% in multiple level pathologies and 55% in FBSS. Sophisticated endoscopic techniques were trying to find place all along with the standard operative methods.

MIS-TLIF, EELD, TELA procedures were quite encouraging in selected patients. Mini invasive techniques were mandatory in pregnant patients after precise interdisciplinary discussion.

Operative or conservative treatment meta analyses did not give clear answer to the question: What was the best treatment for this pathology. To be precise (at least theoretically) one had to keep in mind the fundamental studies of Gruber & Hanley, Roberts et al., on the topic of the discal degeneration.

Modic MRI classification on the discal-end plate status, Thompson and al. histological classification enlarge our understanding of the problem. Mode of treatment in cases of recurrent discal herniations was debatable.

Cell transplantation (autologous lipocytes and disc chondrocytes) in cases of the “aging disc” were under discussion recently.

Emergency LDH patients did not bear higher postoperative risks.

In the last 30 years there were few defended PhD theses on spinal pathologies. The authors, being outstanding BC/BE specialists – neurosurgeons and orthopedics. Quite logically they called themselves – spinal surgeons.

Analysing the literature data we concluded:

- Our knowledge in the field of pathoanatomy, pathophysiology and pathobiochemistry of the discal disease was continuously enlarging.
- Up to the middle of the 90-ies “gold standard” to treat this pathology was not found.
- Surgical treatment showed advantages in the first 4 years postoperatively (SPORT trial).
- A delicate dialogue was mandatory between the surgeon and the patient to create a “gold standard” satisfying the patient’s expectations in respect with the surgeon’s skill.
- Still there was no rightful answer to the question – “what was symptomatic herniation”? Possibilities: 1.Back pain 2. Radicular pain 3. back and radicular pain at the same time.
- There was no standard medical protocol.
- Methodological misunderstandings brought impediments in the efforts to construct perfect studies in the field.
- Sophisticated mini invasive techniques were broadly introduced after 1977
- The best treatment for LDH was still not rightfully proved.

## **Objective (aims, purposes, tasks)**

### **Hypothesis:**

- strict medical algorithm was mandatory to expect perfect treatment outcomes, suffering LDH.
- anamnesis, present neurological status, CT and MRI data, all along with the process of seeking “the gold standard” were basic and important criteria for achieving prodigious treatment results

### **Aim:**

Analyzing surgically treated LDH patients in our clinic, to detect the clinical efficacy of SOD.

We set before us the following tasks:

1. To create a system (Microsoft Excel) for registration of the cases to be analysed according to predefined criteria for inclusion into the study. Then render an account of the outcomes for a period of 1-5 years.
2. To figure out the conservative treatment results for patients with CT and MRI verified LDH for a period of 5 years.
3. To study and compare the results of SOD and MD operated patients one year after the operative treatment.
4. Conservative vs surgical treatment – analyzing the effectiveness of the two methods



## **Materials and methods**

### **Investigational protocol**

**Objects:** Patients treated in our clinic with CT and MRI confirmed diagnosis - LDH (treated between 2012-2017) either by SOD or MD. Also conservatively treated patients in the neurological clinic between 2012-2017.

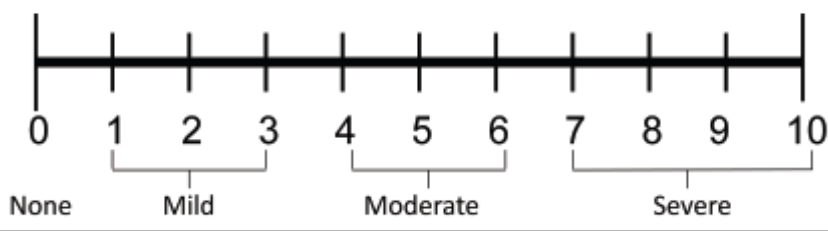
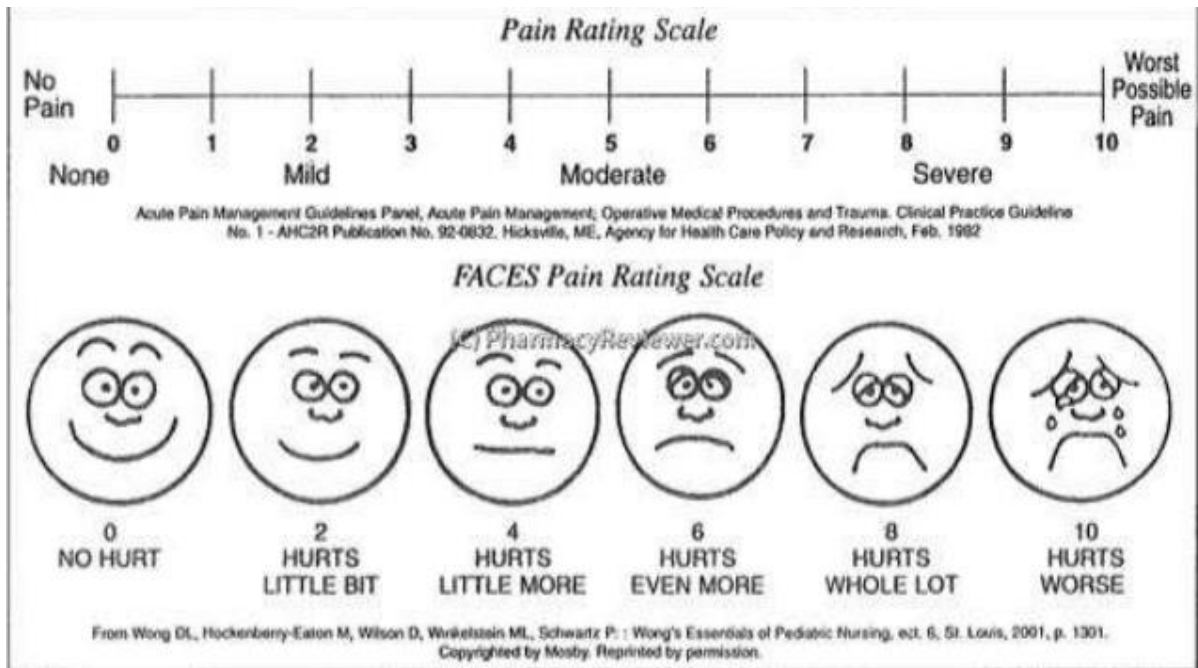
**Subject:** Results after conservative and surgical treatment on the territory of the department according to complex estimation of the outcomes.

**Clinical contingent.** Some 614 patients were investigated. Different technical reasons excluded 25 (4,7%) of them. 589 were included into the study. 147 were treated conservatively in neurology clinic between 2012-2017. 95 of them (64,6%) were included into the study. The assessment of neurological outcomes were figured out according to VAS (in-out) criteria 1-5 years after the treatment.

### **Algorithm, inclusion criteria and outcome assessment**

#### **I. Clinical methods**

1. Anamnesis – accent on the time of onset, therapeutic effectiveness and co-morbidity – namely arterial hypertension, diabetes mellitus, oncologic and orthopedic diseases.
2. Neurological status – standard protocol, characterizing the vertebral and radicular syndromes.
3. Fixing postoperative complications after the Cliven-Dindo classification in the first 30 days postoperatively, based on needed medication to correct the presumable complication. 5 grades to “measure” the problem (the 5th being death). The other 4 being: gr. I – normal postoperative status. Medication to use – antiemetic drugs, antipyretics, analgesics, antibiotics. gr.2 – need for second analgetic, corticosteroids, blood transfusion, parental nourishment. Infection of the operative wound is observed. gr.3 – reoperation needed (endoscope, radiology). gr. 4 – life threatening complication, including CNS problems, ICU needed.
4. Postoperative outcome assessment according to the neurological status, VAS and Macnaab criteria



**Fig.1** Visual analogue scale (VAS). Patients was expected to assess 3 times in 24 hours the level of pain intensity to figure out the mean arithmetical values. Graduation values are – 1-3, 4-6, and 7-10 respectively.

**Tabl.1** Modified Macnaab criteria for postoperative satisfaction self estimation of the patient. 4 possible answers.

**Modified MacNab's Criteria**

- Excellent: No pain, No restriction of mobility, Return to normal work and level of activity
- Good: Occasional nonradicular pain, Relief of presenting symptoms, Able to return to modified work
- Fair: Some improved functional capacity, Still handicapped and/or unemployed
- Poor: Continued objective symptoms of root involvement, Additional operative intervention needed at index level irrespective of length of postoperative follow-up

In our clinic we used the Revised Oswestry Disability Index (for low back pain/dysfunction). Patient answered just with one answer to each of the following sections: pain, self-attendance/service, lifting heavy objects, walking, sitting, standing, sleep, social activities, travelling, level of pain fluctuation.

Efficacy of treatment (1-5 years after) according to the ODI questionnaire (this was done at times of control examinations) or after phone call invitations.

**Tabl. 2** ODI – objective for measuring the constant functional problems. This was 10 sections geostationary (upper mentioned). The answer at the upper bar gives 0 point; the lowest gives 5 points. So the maximal possible sum is 50 (this means 100%). Practically; if one calculated a sum of 17, that means –  $17/50 \text{ max. } \cdot 100 = 34\%$ . One answer to miss was acceptable.

Interpretation of the result is as follows:

### Interpretation of scores

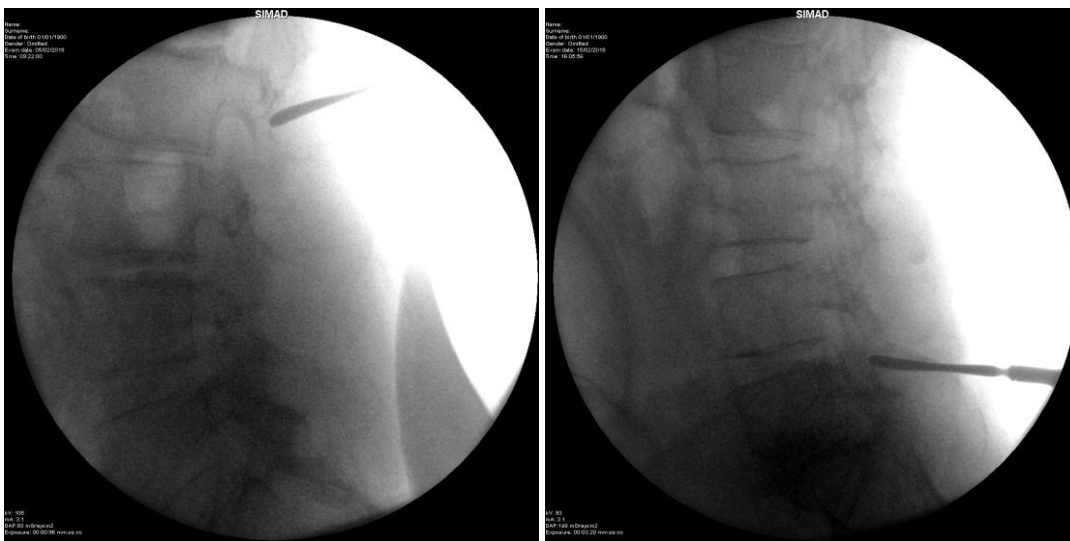
<b>0% to 20%: minimal disability:</b>	The patient can cope with most living activities. Usually no treatment is indicated apart from advice on lifting sitting and exercise.
<b>21%-40%: moderate disability:</b>	The patient experiences more pain and difficulty with sitting, lifting and standing. Travel and social life are more difficult and they may be disabled from work. Personal care, sexual activity and sleeping are not grossly affected and the patient can usually be managed by conservative means.
<b>41%-60%: severe disability:</b>	Pain remains the main problem in this group but activities of daily living are affected. These patients require a detailed investigation.
<b>61%-80%: crippled:</b>	Back pain impinges on all aspects of the patient's life. Positive intervention is required.
<b>81%-100%:</b>	These patients are either bed-bound or exaggerating their symptoms.

## 5. Operative treatment

### Standard discectomy

This operation is performed under general anesthesia. The patient is in a prone position with flexed hip and knee joints. The skin incision is made along the midline over the three spinous processes, its mid-point being at the level of the affected disc. The thoracolumbar fascia is exposed and is detached from the spinous processes and the supraspinal ligament. The two laminae and the interspace are exposed together with the articular processes. In this dissection, the sacrum need to be carefully identified, as it oriented the surgeon concerning the correct localization of the disc level. A possible problem is a “mismatch” with the level of pathology. The solution to this problem could be verification of the level pre- and intraoperative with the

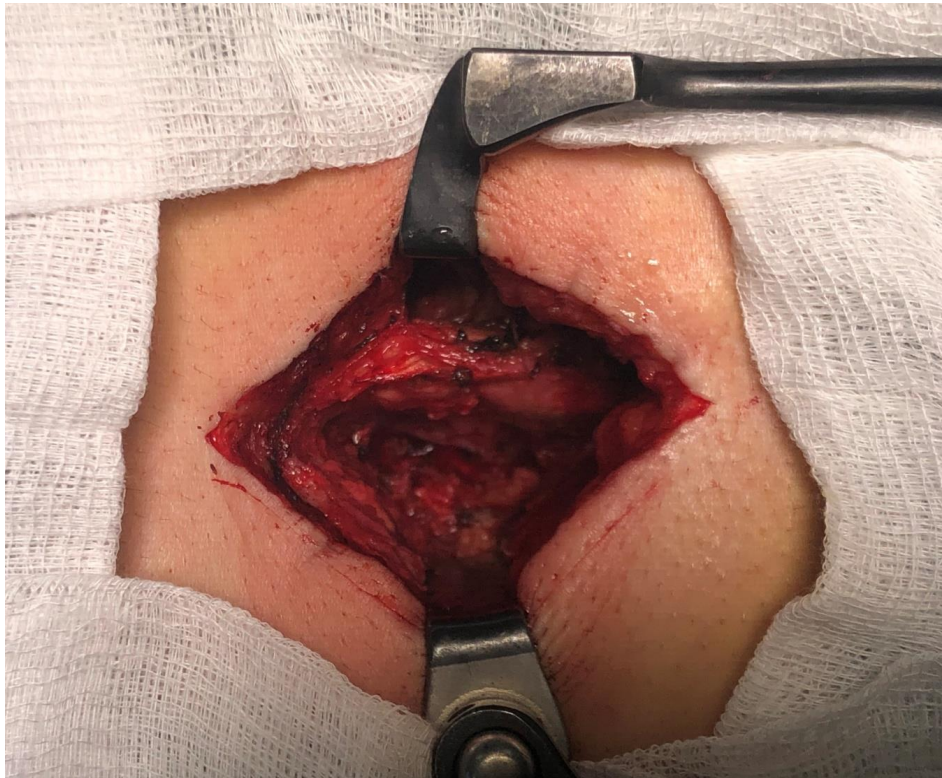
C-arm Simad. The bleeding as a problem is stopped by electrocoagulation and tamponade for a few minutes. A self-retaining retractor is applied (Figure 1). The flavum ligament is removed with a Kerrison's instrument. It is usually necessary to remove the inferior edge of the higher lying lamina. This is done with a Kerrisons' instrument or with a small electric drill. If bleeding occurred, it need to be stopped with bone wax. The next step is retracting the epidural fatty tissue. The nerve root, situated in the dural sleeve, seemed in most cases considerably stretched. That is why it had to be carefully separated from the underlying disc prolapse and medially displaced with a root retractor so the prolapse could be revealed. A root that was not stretched could be easily retracted.



**Fig. 2** Intraoperative verification of the lumbar level.



**Fig 3. a/b** „Huge” fragment of disc herniation extirpated.



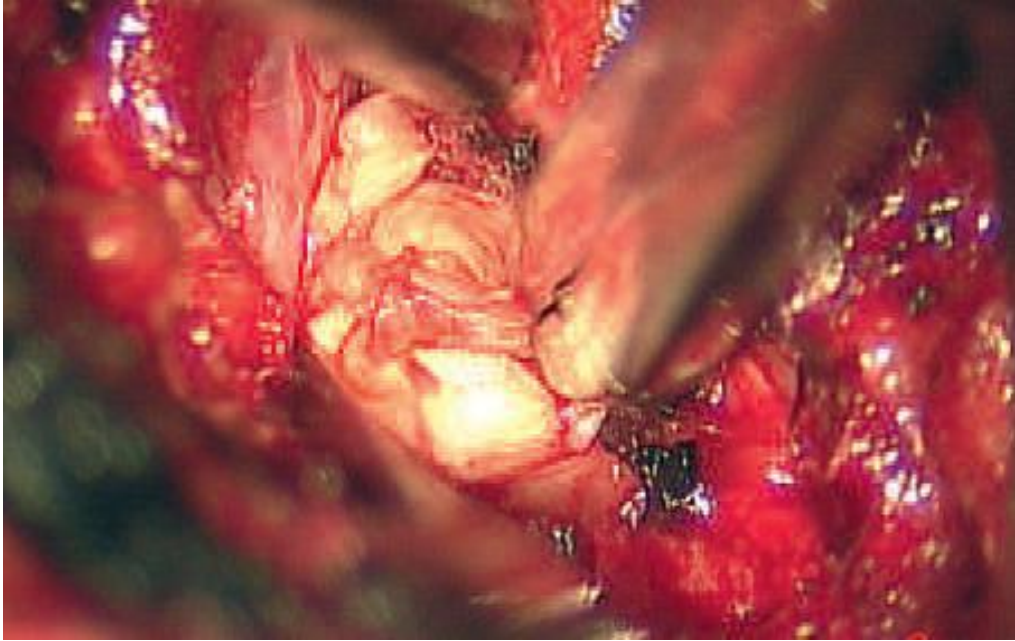
*Fig.4a Dural sac and radix are lying free at its place.*



*Fig.4b 4,5 cm incision of the midline (SOD).*

### **Microscopic discectomy**

We used a Carl Zeiss microscope, magnification up to 4X. The incision on the midline is 3 cm. Muscle aponeurosis is incised 1 cm from the midline. Muscle multifidus is separated from the spinous processes to the joint laterally, and then the speculum has been inserted and opened. The microscope is focused to the operative field.



**Fig. 5** Microdiscectomy using a Carl Zeiss microscope, magnification up to 4X. "Huge" disc herniation in the operative field.

## II. Instrumental methods

- CT
- MRI

Disc assessment according to Phirman scale.



**Fig.6** Visual Model of the 5th grade scale.

The upper mentioned tool made the intraoperative findings standardized, making the mode of treatment logical and eloquent. Used are CT and MRI devices that were actual at the time in the MU-Pleven region.

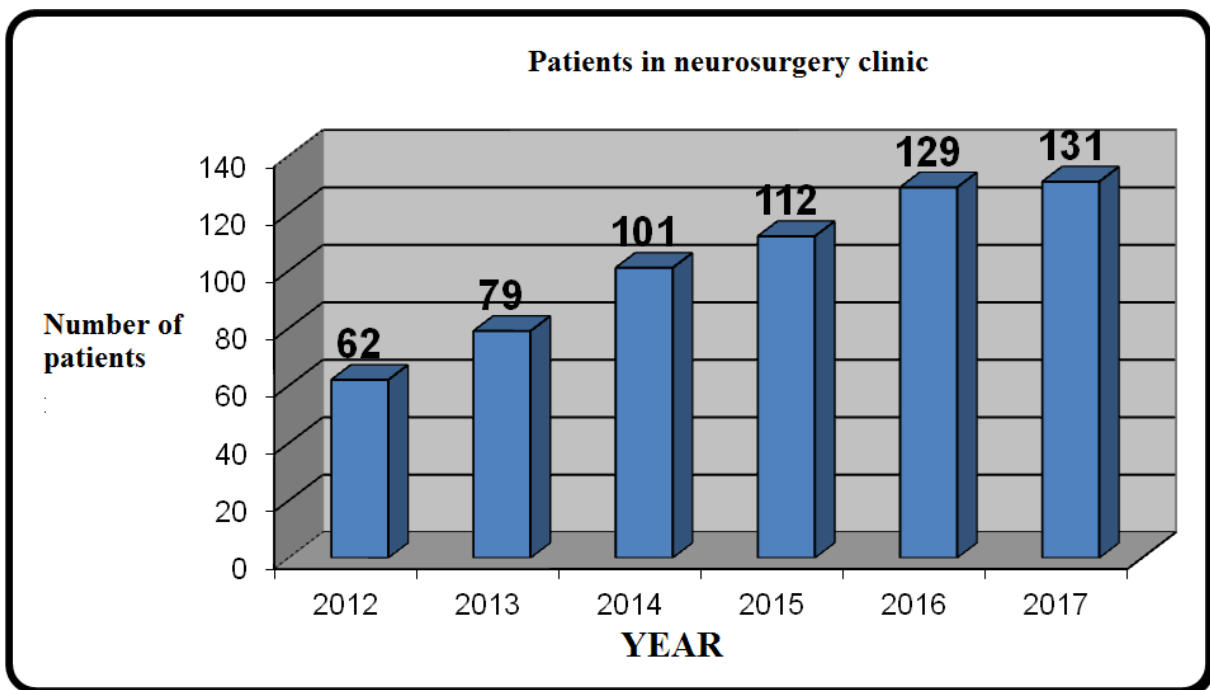
## III. Statistics:

- Quantitative indicators (percentages)
- ANOVA
- multivariate tests
- Continuity Correction

- Likelihood Ratio
- Fisher's Exact Test
- Linear-by-Linear Association
- N of Valid Cases, Post Hoc Tests

**Results:**

- Operative treatment for LDH tended to increase their number (2012-2017). Small number of patients were excluded from the study (4.07%) due to technical reasons mainly.

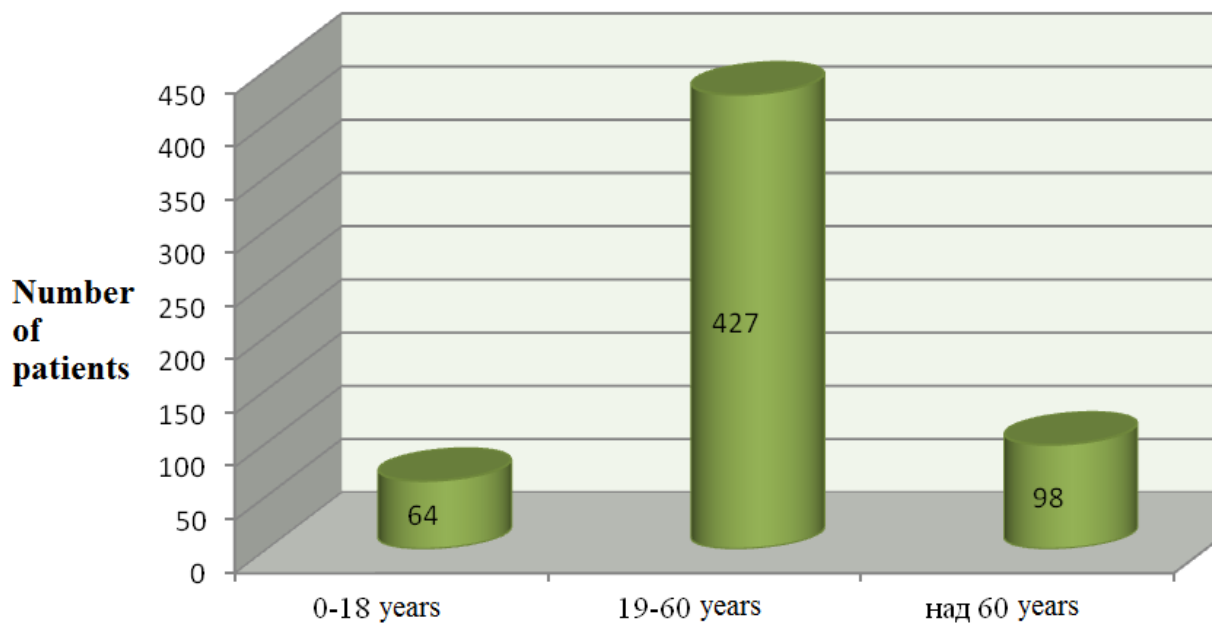


**Fig. 7.** *The number of operated cases follows a steep trend up (2012-2017)*

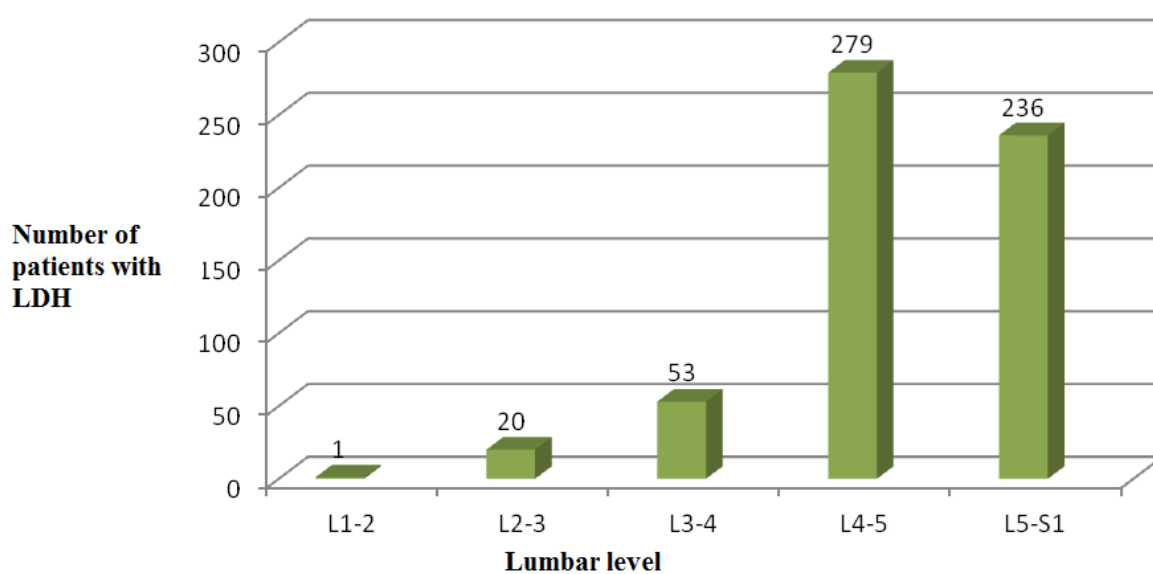
- The highest number of operated patients was between 19-60 years of age. Preferable levels of pathology were L4-5 (47%) and L5-S1 (40%). This correlates with the literature data. LDH on two levels simultaneously is a relatively rare finding – in our study they occurred in only 3% of the examined patients.

Age group:	Number of patients:	Percentage:
0-18 years	64	11%
19-60 years	427	72%
over 60 years	98	17%

**Table 3.** Number of patients by age.



**Fig.8.** Number of patients by age – graphic



**Fig.9.** Number of patients by level of pathology



			SEX		TOTAL
			M	F	
Number of LDH	1	Number	310	260	570
		% by number of LDH	54,4%	45,6%	100,0%
		% by sex	96,9%	96,7%	96,8%
	2	Number	10	9	<b>19</b>
		% by number of LDH	52,6%	47,4%	100,0%
		% by sex	3,1%	3,3%	<b>3,2%</b>
Total	Number	320	269	589	
	% by number of LDH	54,3%	45,7%	100,0%	
	% by sex	100,0%	100,0%	100,0%	

**Tabl.4.** Only 19 patients (3.2 %) were with two levels of pathology

- 3.31% of patients declared sudden onset of the symptoms, mainly in connection to lifting a heavy object, spinal trauma and sport.

**Table.5.** Sudden onset connected to

Heavy weight lifting	121
Sport	24
Spinal trauma	21
Other	15
All	<b>181</b>

**Table.5.** Sudden onset connected to

	LDH (other causes)	LDH after lifting a heavy object	
	n - 468	n - 121	
Oswestry Disability Index (0-100)	50 ± 21	61 ± 17	p=0.10
Visual Analog Scale Leg Pain (0-10)	6.9 ± 2.4	7.8 ± 2.3	p=0.19
Visual Analog Scale Back Pain (0-10)	5.1 ± 3.3	5.6 ± 3.8	p=0.54

**Table 6.** Heavy weight lifting correlated to the severity of the clinical picture

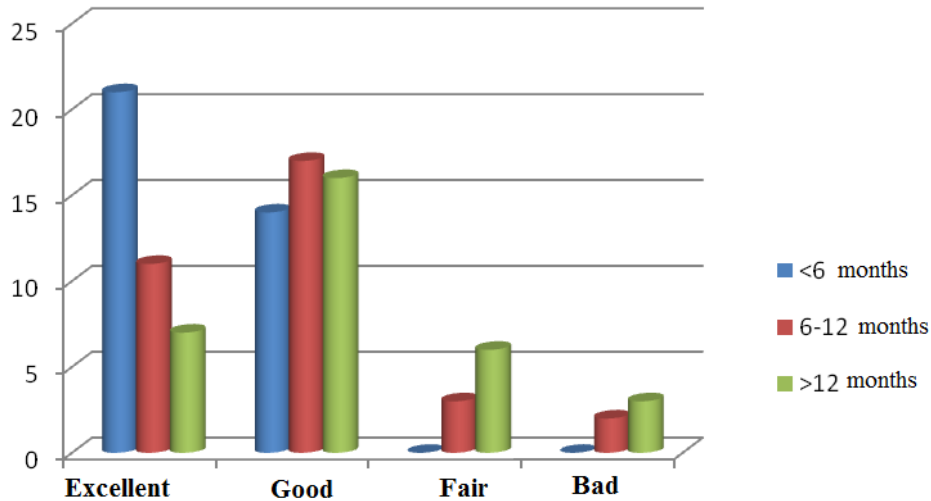
- 4.29% of patients had comorbidities: 54% with arterial hypertension, 34% with diabetes mellitus, 5% were oncologic patients and 7% had joint diseases. Combination of arterial hypertension and diabetes mellitus was most often found.
- 85% of the patients were previously treated with other types of therapies (conservative treatment, manual therapy, ozone therapy)
- 100 randomly selected patients with different time-related preoperative complains were investigated 1-3 years postoperatively with the MacNaab criteria. Those who had suffered more than 6 months gave worse assessment of their postoperative status. This is a relative proof of the benefit to recommend neurosurgical consultation at the earliest convenient time for the patient.

	N	%
Excellent	39	86
Good	47	
Fair	9	14
Poor	5	

*Table 7 Patients' estimation of their own condition (MacNaab criteria) 1-3 years postoperatively (n=100):*

Symptoms (time-related)/postoperative outcome	Excellent	Good	Fair	Poor
<b>&lt;6 months</b>	21	14	0	0
<b>6-12 months</b>	11	17	3	2
<b>&gt;12 months</b>	7	16	6	3

*Table 8 Comparing the longevity of the preoperatively experienced symptoms and the postoperative results:*



**Fig.10** 100 randomly selected patient/symptoms (time related) preoperatively. Evidently the longer period of elapsed time preoperatively leads to worse self-estimated postoperative status.

	Back to previous job	Other job	Non-employed
<6 months	33	2	0
6-12 months	28	3	0
>12 months	23	7	4
	<b>84%</b>	<b>12%</b>	<b>4%</b>

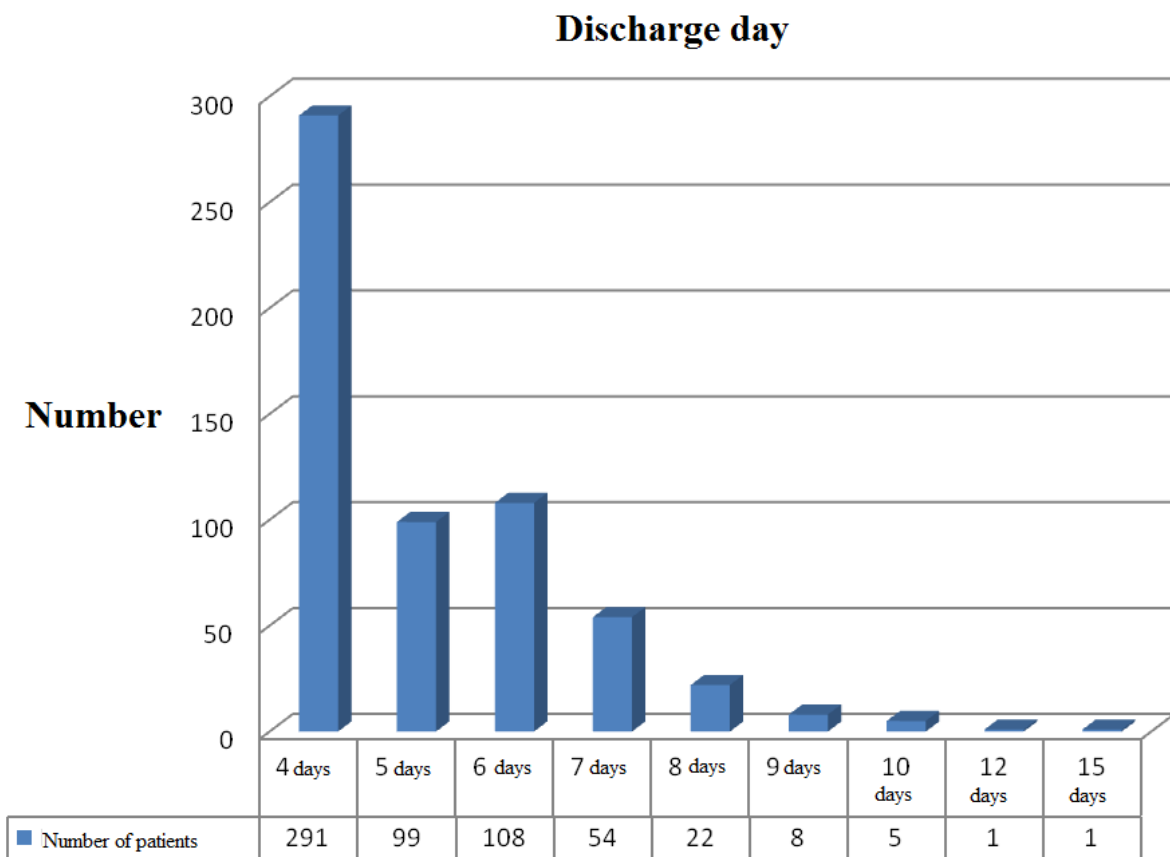
**Table 9.** Attenuated working capacity was observed when the patient had postponed consulting a neurosurgeon:

- 50% of all patients stayed for 4 days in the hospital after surgery. Namely 80% of all patients were given postoperative medical care for 5-6 days. The early postoperative complications according to Clavien-Dindo classification were as follows: Grade III: 1.35% of all patients (i.e. 8 patients (6 men and 2 women) were re-operated on within the first month). In those patients we found a “silent/hidden” disc material at the same level as the first operation. We did not observe any Grade IV or Grade V cases.

Days at the hospital	Number	Percentage:
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	<b>of patients</b>	
4 days	291	50%
5 days	99	17%
6 days	108	18%
7 days	54	9%
8 days	22	4%
9 days	8	1%
10 days	5	1%
12 days	1	0.01%
15 days	1	0.01%
	<b>589</b>	<b>100%</b>

*Table 10 Postoperative days in hospital - 291 patients (50%) were given medical care for 4 days. 207 (30%) stayed at the hospital for 5-6 days, thus 80% of the patients were hospitalized for 4-6 days.*



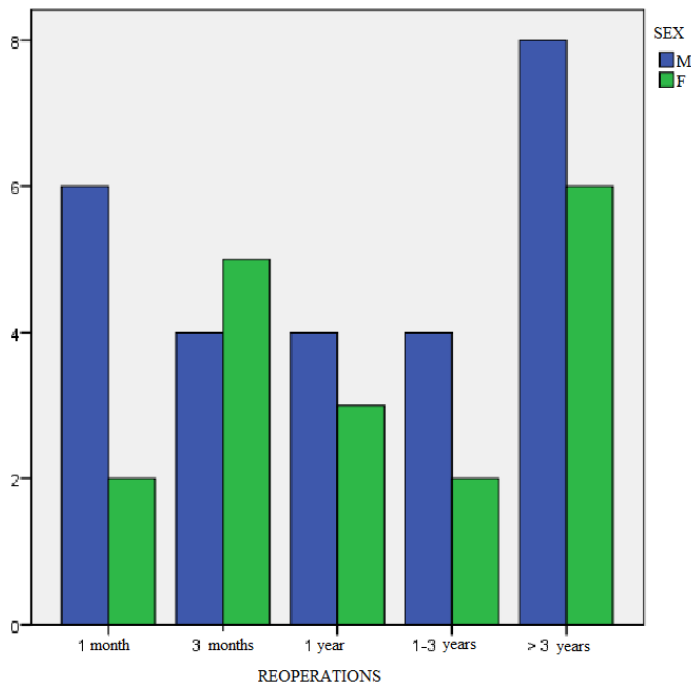
*Fig.11 Graphic presentation of the data mentioned above*

<b>Early complications (The Clavien-Dindo</b>	<b>Percentage</b>
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classification)

<b>Grade I</b>	449	76.3%
<b>Grade II</b>	132	22.4%
<b>Grade III</b>	8	1.3%
<b>Grade IV</b>	0	0%
<b>Grade V</b>	0	0%

*Table 11 Early postoperative complications (up to the 30<sup>th</sup> postoperative day) according the Clavien-Dindo classification:*



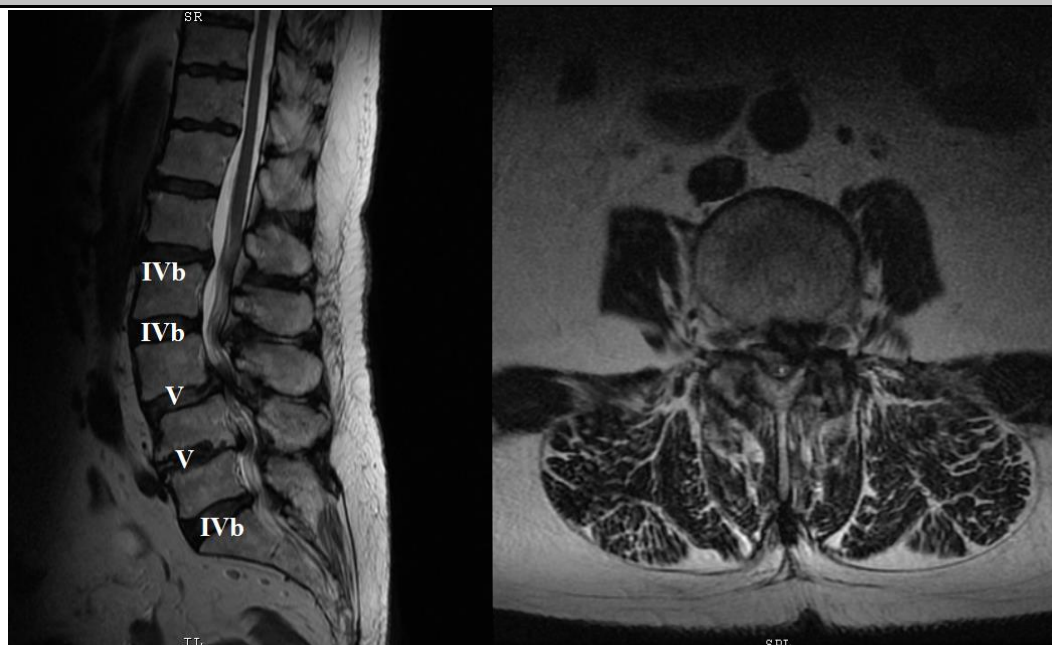
*Fig.12 Up to the 30<sup>th</sup> day 8 patients were re-operated on (silent/hidden disc found). Those cases were 18.2 % of all reoperations during the 3-year period of investigation.*

- *MRI estimation of the disc status had been carried out in 140 patients using the Phirman scale. Out of them 20 random patients were correlatively investigated at the time of discharge using the VAS (back and leg pain) and MacNaab classifications. It was proven that younger patients with Phirman I-II for the disc levels adjacent to the level of pathology showed significantly better VAS/MacNaab postoperative results than the elderly patients.*

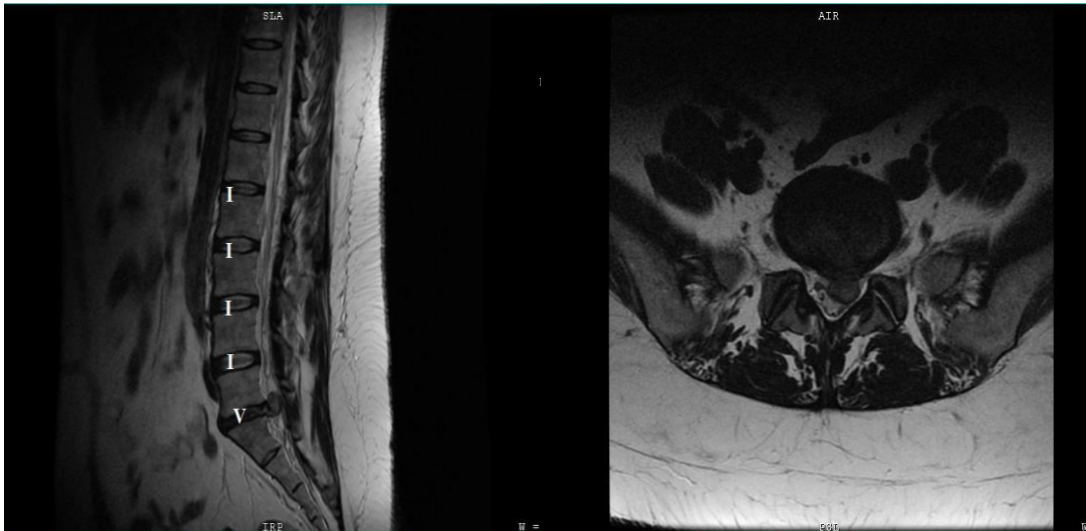
**Table 12** 20 random patients were estimated correlatively using the following criteria: MRI data of the disc status using the Phirman scale; VAS and MacNaab classifications (self-estimation) at the time of discharge.

PHIRMAN SCALE	20 RANDOM PATIENTS								
	YEARS	L1-2	L2-3	L3-4	L4-5	L5-S1	VAS(back pain)	VAS (leg pain)	MacNaab
PATIENT 1	28	I	II	I	I	V	1	1	EXCELLENT
PATIENT 2	39	I	I	I	I	V	1	1	EXCELLENT
PATIENT 3	47	III	IV-a	V	III	II	2	2	GOOD
PATIENT 4	44	I	II	III	V	II	1	1	EXCELLENT
PATIENT 5	58	III	IV-b	III	IV-a	II	2	2	GOOD
PATIENT 6	37	I	I	I	V	I	1	1	EXCELLENT
PATIENT 7	70	IV-a	III	III	III	V	3	1	FAIR
PATIENT 8	33	I	I	I	IV-b	I	1	1	EXCELLENT
PATIENT 9	43	II	I	II	I	IV-b	2	1	GOOD

PATIENT 10	55	II	II	III	III	IV-b	2	2	GOOD
PATIENT 11	63	IVb	IVb	V	V	IV-b	3	2	FAIR
PATIENT 12	63	II	III	IV-b	IV-a	II	2	2	GOOD
PATIENT 13	50	I	II	II	II	V	1	1	EXCELLENT
PATIENT 14	65	II	II	III	IV-a	V	2	2	GOOD
PATIENT 15	51	II	II	II	IV-b	II	1	1	EXCELLENT
PATIENT 16	48	I	II	II	III	IV-a	2	1	GOOD
PATIENT 17	54	III	III	IV-a	IV-a	V	3	3	FAIR
PATIENT 18	15	I	I	I	V	I	1	1	EXCELLENT
PATIENT 19	52	I	II	II	I	IV-b	1	1	EXCELLENT
PATIENT 20	40	I	I	II	II	V	1	1	EXCELLENT

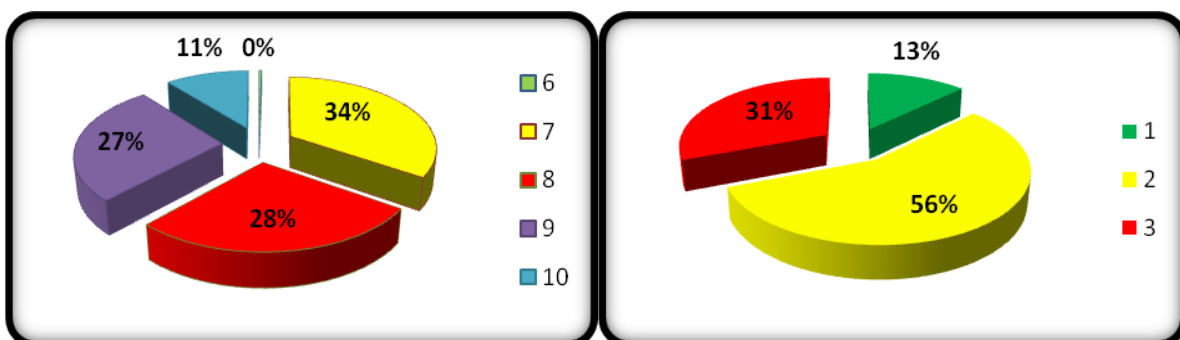
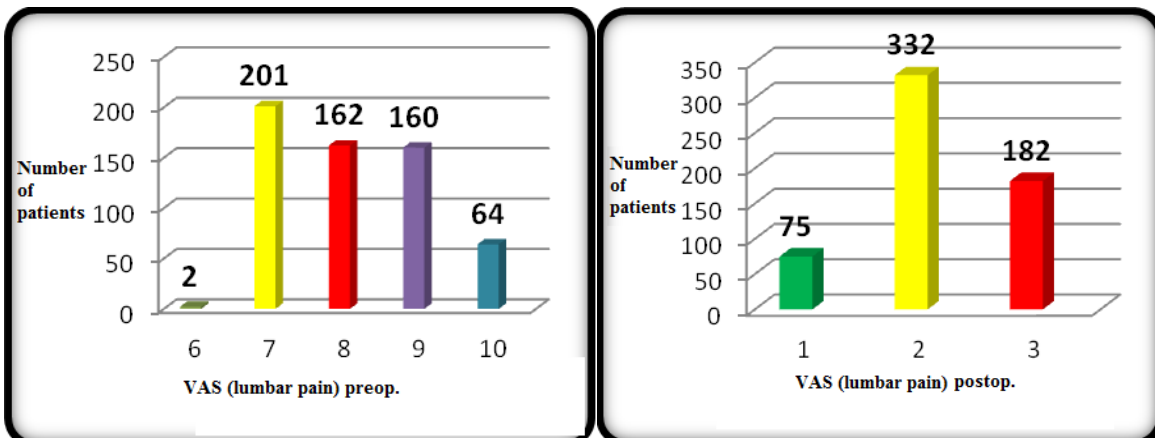


**Fig.13** Example – a 63-year-old patient with stenosis at the L4-5 level and disc herniation at the L3-4 level. MacNaab assessment – fair. **Note:** Using multiple level decompression with fusion as technique may give good results in this patient.



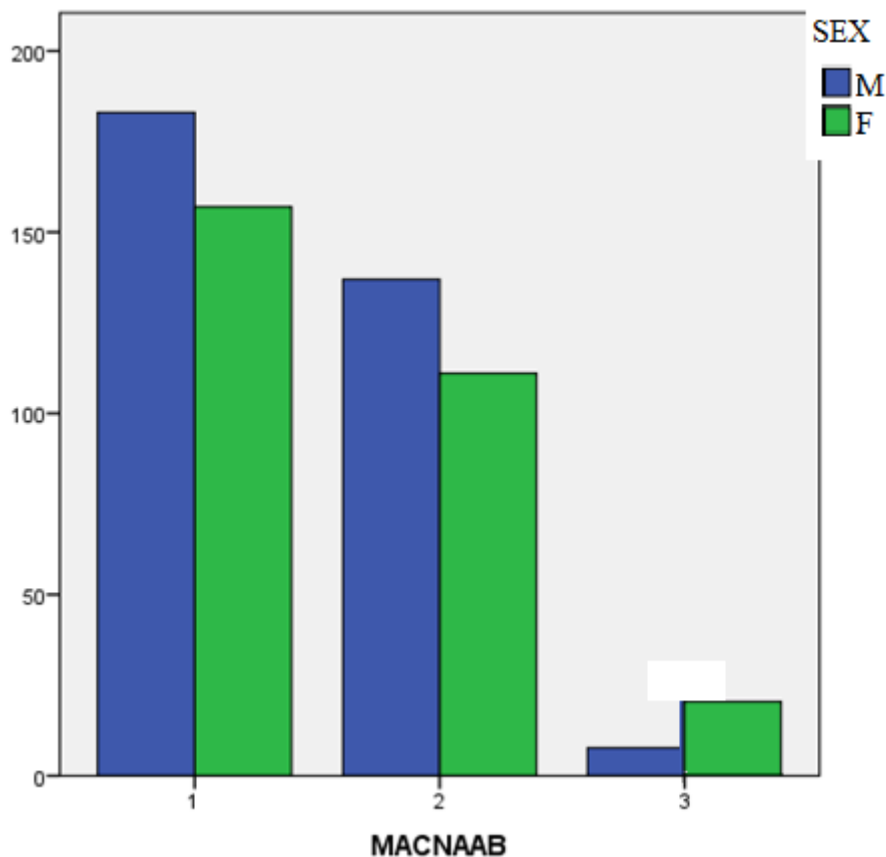
**Fig.14** Example – a 39-year old patient with a disc herniation at the L4-5 level. MacNaab assessment – excellent.

- VAS in/out results for back pain give a very fair assessment of the patients' condition



*Fig. 15 and 16 VAS in/out number of patients and percentages*

- Regarding leg pain, the VAS in results are as follows: VAS 6 – 32%; 20% of the patients experience severe pain – VAS 9-10. The VAS out results (at the time of discharge: 70% are VAS 1-2 and 30 % are VAS 3



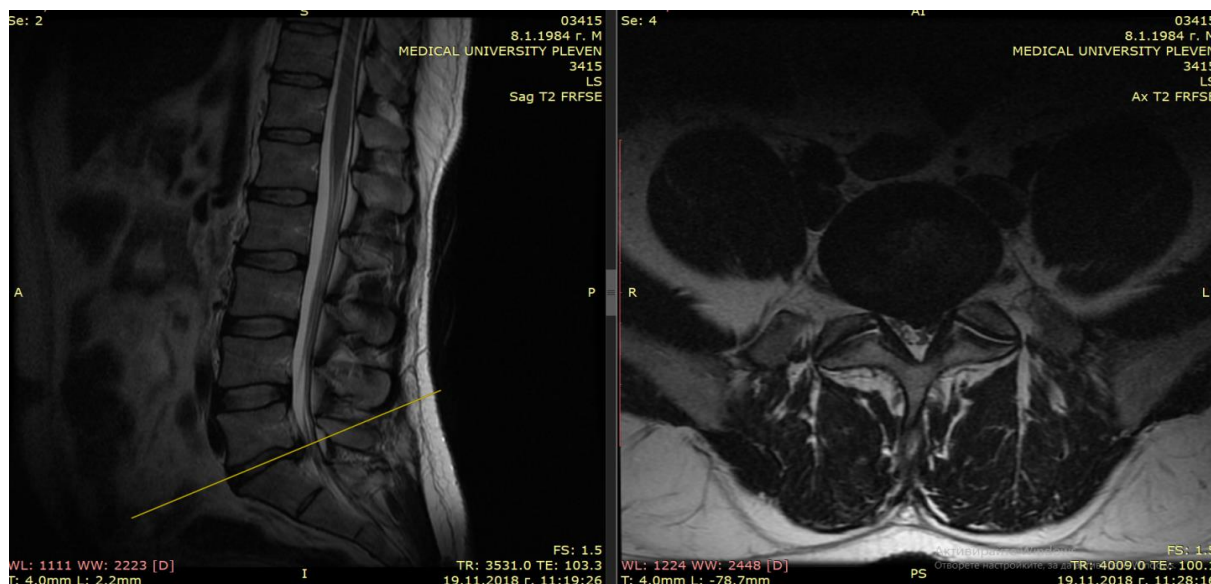
*Fig.17 Modified MacNaab criteria for the patients' condition*

- Most of the cases had undergone surgery in the 6-month period from the onset of the symptoms. Only 60 patients were operated on after experiencing symptoms for more than 12 months. From those cases only 11 were operated on using the MD method. 50 cases that were initially operated on using MD were eventually operated on with the standard discectomy.
- The ODI in the patients' daily life during the first year after surgery (in 493 patients) and during the first 5 years after surgery (in 90 patients), shows a minimal dysfunction (0-20%)
- Reduction of the VAS mean values depending on the chosen treatment method (conservative or surgical):



**Table 13**

2013 г.	
Conservative treatment	VAS- mean values drop by 2.4 p
Surgical method	VAS- mean values drop by 3.0 p.
2014 г.	
Conservative treatment	VAS- mean values drop by 1.1 p
Surgical method	VAS- mean values drop by 5.5 p
2015 г.	
Conservative treatment	VAS- mean values drop by 1.5 p
Surgical method	VAS- mean values drop by 5.0 p
2016 г.	
Conservative treatment	VAS- mean values drop by 1.0 p
Surgical method	VAS- mean values drop by 5.0 p
2017 г.	
Conservative treatment	VAS- mean values drop by 1.3 p
Surgical method	VAS- mean values drop by 5.8 p



**Fig.18** A 34-year-old patient that was admitted to the Neurology department for conservative treatment. VAS in results – 9p (severe vertebral and radicular syndromes). There was no noticeable effect of the conservative treatment. On the 5<sup>th</sup> day after surgery the patient declared VAS values of 1p.

The following conclusion can be made:

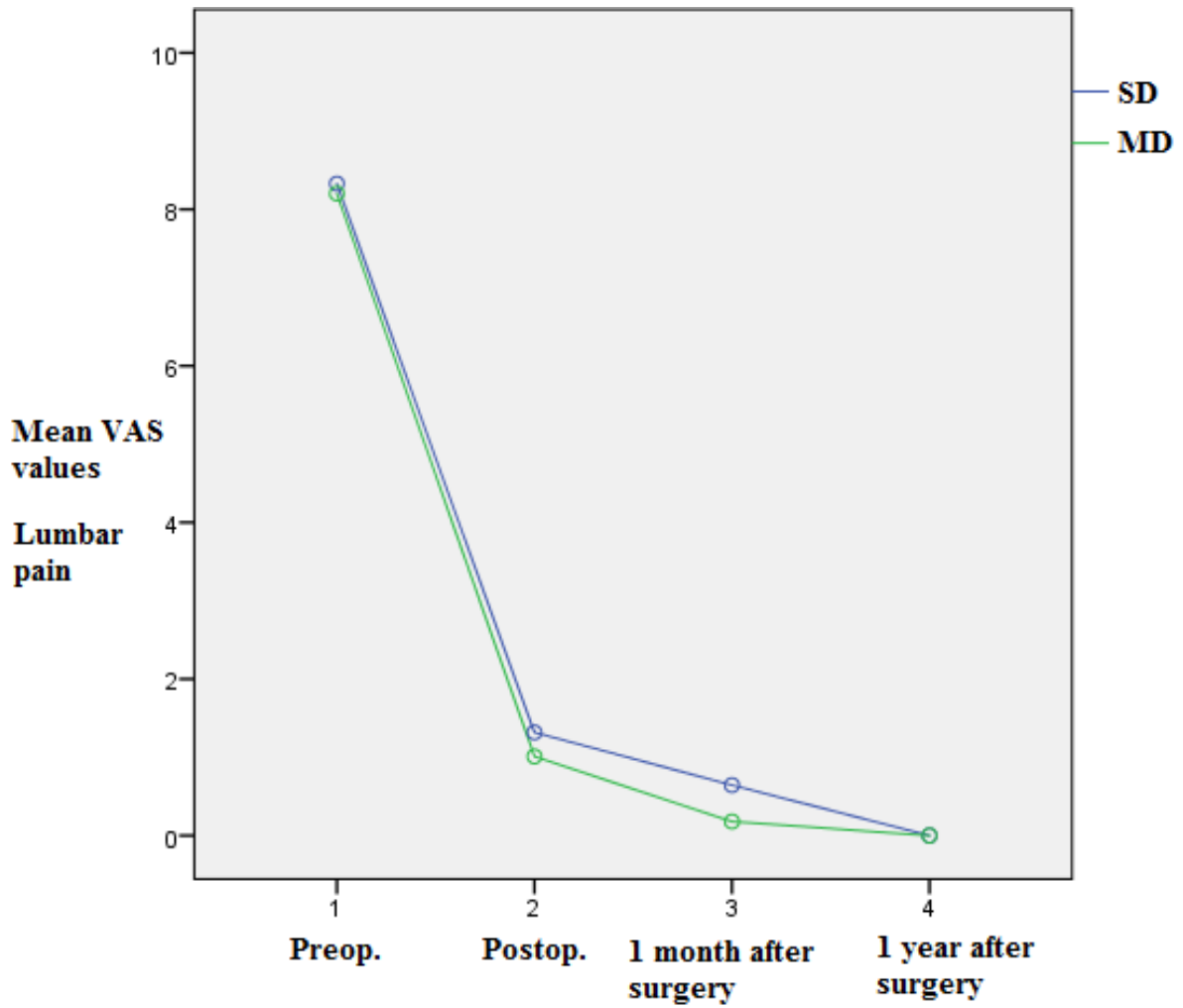
We still were unable to precisely assess the effectiveness of the surgical treatment compared to the conservative treatment in patients with disc radiculopathies. Such precision can be achieved in future prospective studies.

Despite this, the recent postoperative results were beyond discussion. In this study, the excellent VAS postoperative values (in the course of 5 years) were statistically insignificant.

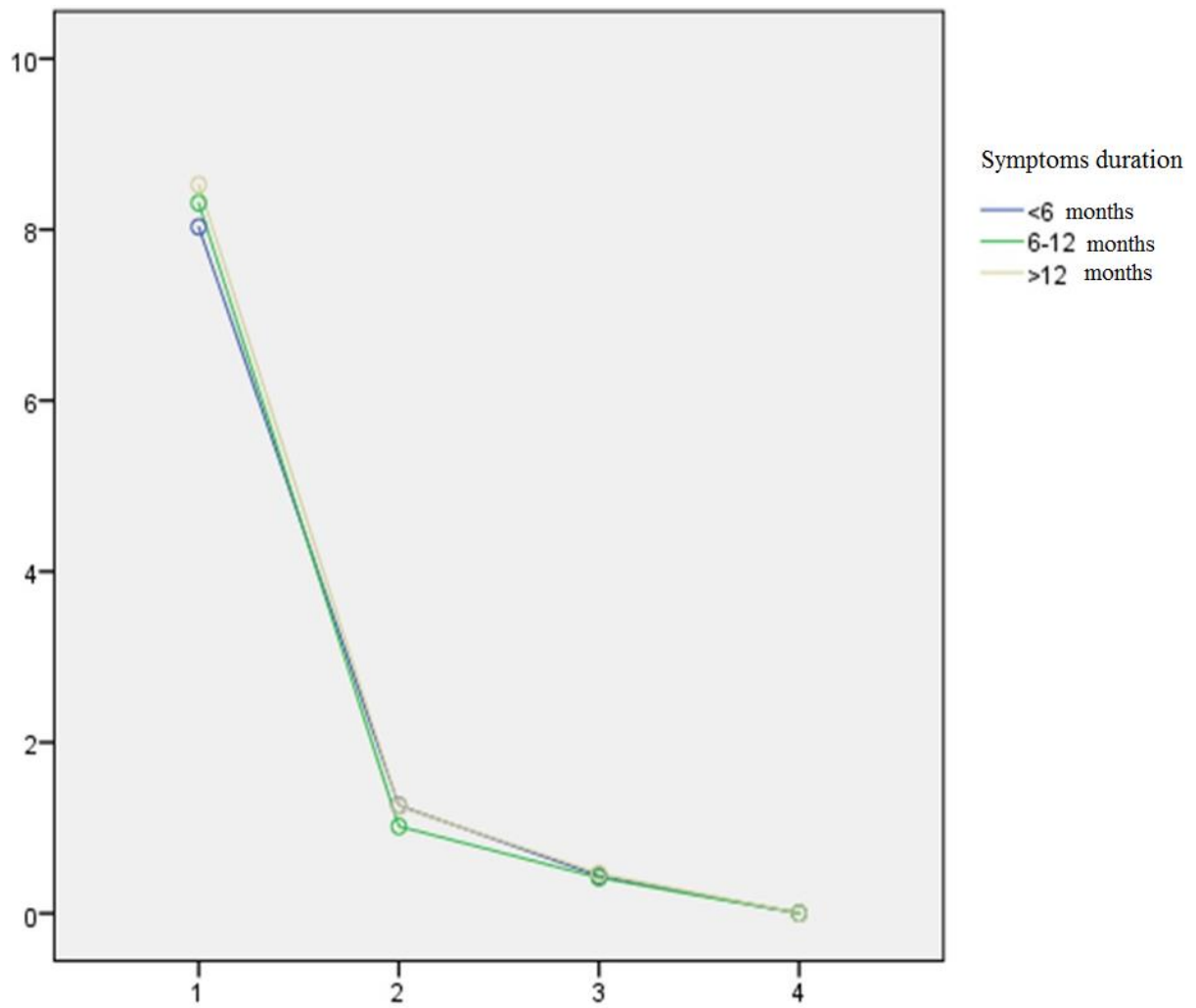
The most important criteria to recommend surgical treatment to the patient were:

- Anamnestic data and clinical manifestation (regardless of the duration of the patient's complaints) along with an unequivocal MRI finding.
- A dialogue between the surgeon and the patient aiming to elaborate the "gold standard" that satisfies the patient's expectations of the result of the treatment, on one hand, and the surgeon's undoubtful skill, on the other.
- ANOVA statistical differences for the mean pain values when MD or SOD was performed. The MD provides better results in patients whose symptoms initiated less than 6 months ago and in older patients. This is due to the fact that the SOD operative wound is more excessive. After the first year the statistical differences tend to equalize.

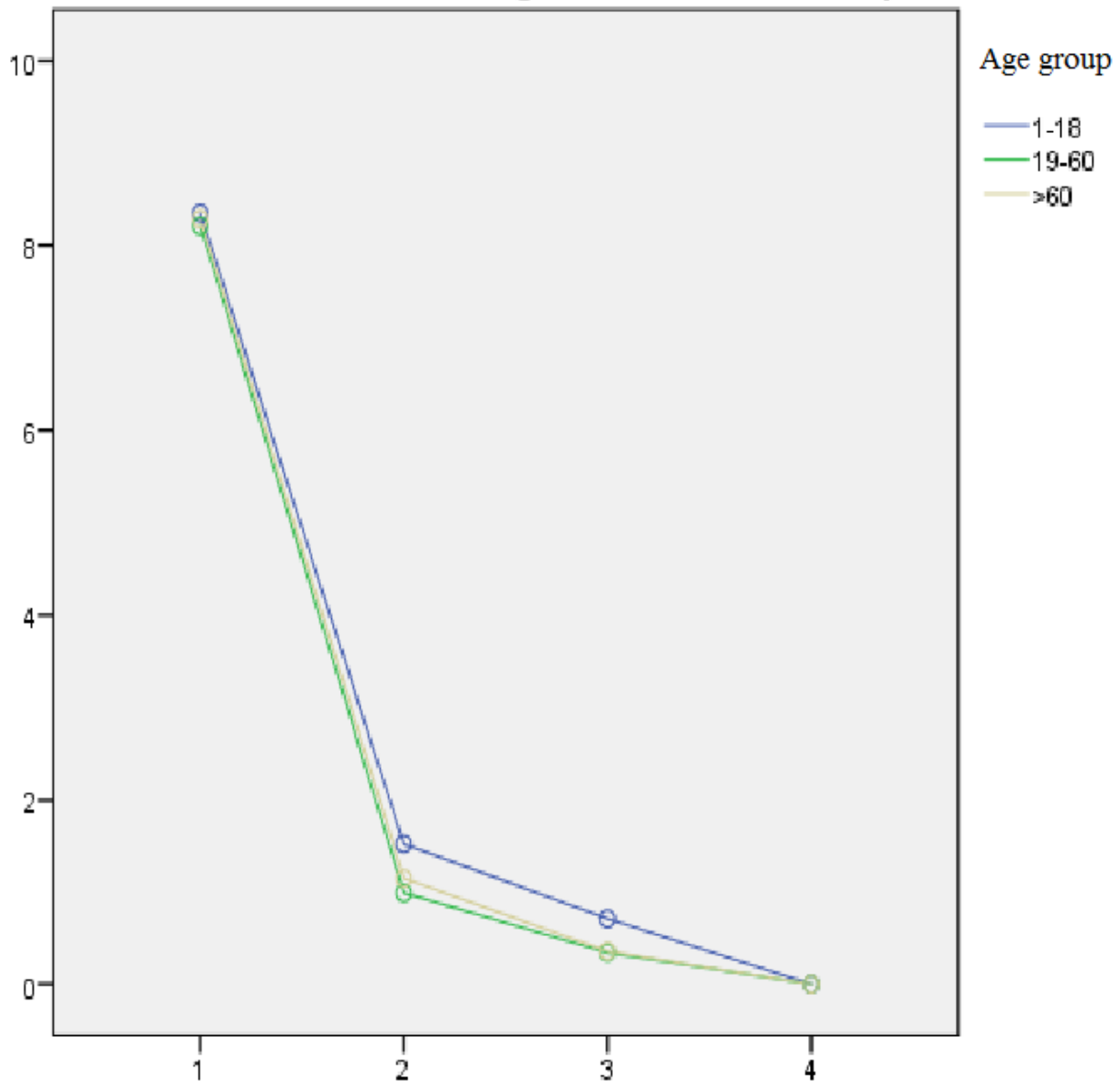
ANOVA (lumbar pain )	Standard open discectomy (N=498)	Microdiscectomy (N=91)	P
<b>Post-operative</b>	1.22±0.64	0.97±0.52	P<0.05
<b>1 month</b>	0,51± 0,50	0,25±0,43	P<0.05
ANOVA (leg pain)			
<b>Post-operative</b>	1,20±0.64	0,96±0,51	P<0.05
<b>1 month</b>	0,43±0,49	0,22±0,41	P<0.05



**Fig. 19** Graphic view of the mean VAS (lumbar pain) dynamics in both SOD and MD. **Note:** (v) – mean VAS lumbar pain values; (x) - 1 → pre-surgery, 2 → post surgery, 3 → 1 month post surgery, 4 → 1 year post surgery.



**Fig.20** Dynamics of the mean VAS (back pain) values depending on the longevity of the pre-operative symptoms.



*Fig.21 Dynamics of the mean VAS (back pain) values depending on the age of the patients.*

*Note: Identical results were observed in the VAS (leg pain) mean values.*

## Discussion

### Choosing the topic

Lumbar disc herniation is a frequent pathology in young and middle-aged people. The economic losses caused from it are very difficult for estimation. The US health system claims that the losses near the sum of 1 billion US dollars. This is due to the fact that the problem is quite often underestimated and neglected from medical staff all around the world (starting

from the general physician's consulting room). The SPORT clinical survey showed significant advantages of the surgical treatment of the herniation over the conservative medical treatment. On the other hand, disc herniations that were visible on the imaging tests (CT and MRI) didn't have any symptomatic manifestation. This is the case in nearly 50% of the population. Some studies in the scientific literature stated that around 90% of all patients with LDH recovered and experienced symptom relief without any treatment whatsoever. The joke, that the surgical treatment of the pathology is an easy task, that "we as surgeons use this procedure to take a break from other work" was very far from the truth.

What drew our attention to the problem of the LDH treatment was the frequency of the pathology, the lack of true and completely safe medical protocol, as well as the versatile evaluation outcomes.

## **Literature data**

Up to the middle of the 90s, there was no sufficient literature data discussing this problem. In the past 15-20 years it became quite clear that prospective and randomized clinical studies (such as SPORT – Spine Patients Outcomes Research Trials) could answer the question – what is the optimal treatment for LDH? Certain methodological inconveniences made constructing the study problematic. For example, around 30-40% of the patients refused to have any treatment (either conservative or surgical) or, unexpectedly for the medical staff, changed their chosen treatment options.

**Different clinical studies** showed rather versatile results.

**Standardized medical protocol** should be worked out (starting with the GP's consulting room).

**Ongoing neurological status**, ODI, VAS (in/out), MacNaab criteria should be well accepted in the protocol.

**It would be useful** to introduce the MRI Phirman grading system in order to determine the status of the intervertebral disc in the lumbar region.

**Minimally invasive methods** - PELD, MIS-TLIF, EELD, TELA were reported to give encouraging results.

**Sophisticated animal experiments** encouraged the application of autologic disc chondrocytes (from fat tissue) in humans.

Our goal with this study was to show the importance that SOD has for treating LDH and to demonstrate the place that SOD takes in the process of seeking the “golden therapeutic standard”.

## **Patients, methods and results**

For the period between 2012 and 2017 we have surgically treated 589 patients for LDH in our clinic. Investigations were based on standard criteria that were followed up and the data was strictly followed in the patient’s chart. The retrospective design of the studies for the conservatively treated patients allowed us to only grade the patients using the VAS criteria. Future prospective studies are needed to accurately compare the two methods of treatment. Methods that were used were well accepted and standardized in literature.

Statistics were thorough, thus giving the results a convincing outlook.

### **Results:**

- Patients’ postoperative MacNaab estimation and working capacity were significantly better for those who had undergone surgical treatment up to the 6<sup>th</sup> month from the clinical onset of the symptoms.
- No significant differences between SOD and MD considering surgical time and blood loss were observed
- 80% of all patients had a 4-6 day postoperative hospital care. Only 1.3% of the patients experienced some kind of Cliven-Dindo complications (up to the 30<sup>th</sup> postoperative day)
- The lumbar disc Phirman state was in correlation with the postoperative VAS and MacNaab self-estimation
- All of the re-operations for recurrent herniations (7%) were around the lower percentage described in the literature data (5-15%)

Re-operations (in cases of recurrent symptoms due to re-herniation and comorbidity of the patient) might be a cause for unsatisfactory results for patients, surgeons, hospitals, insurance agents. On the other hand, postoperative infections and other different complications were directly linked to the surgeon’s competence and skill.

The real (true) postoperative disc disease relapse was, as a rule, homolateral and at the same level as the original herniation. Relapse was more often observed in cases where

minimally invasive techniques were applied. We should diagnose this “real” relapse of the disc disease by using enhanced MRI. In most cases such patients would be successfully treated with the second surgery. After selecting our patients with precision by using the Clavien-Dindo classification (gr. III), we reported just 1.3% relapse cases. Extensive annular defects were basic predictors for such relapses.

Smoking compromised the blood supply of the endplate disc zone by causing a vasospasm. Also, nicotine inhibited cell proliferation, collagen formation and extracellular protein synthesis of the pulpous nucleus (Akmal et al.) All those can be a contributing mechanism for a relapse of the herniation.

Other factors that increase the risk of relapse were alcohol and returning to work too early. Willke et al. showed (in vitro) that the “young”, normally hydrated disc was at greater risk for re-herniation when subjected to excessive mechanical stress. At the same time, the pulpous nucleus (more dehydrated and with fibrosis) in patients aged 55 or above showed less inclination for re-herniation.

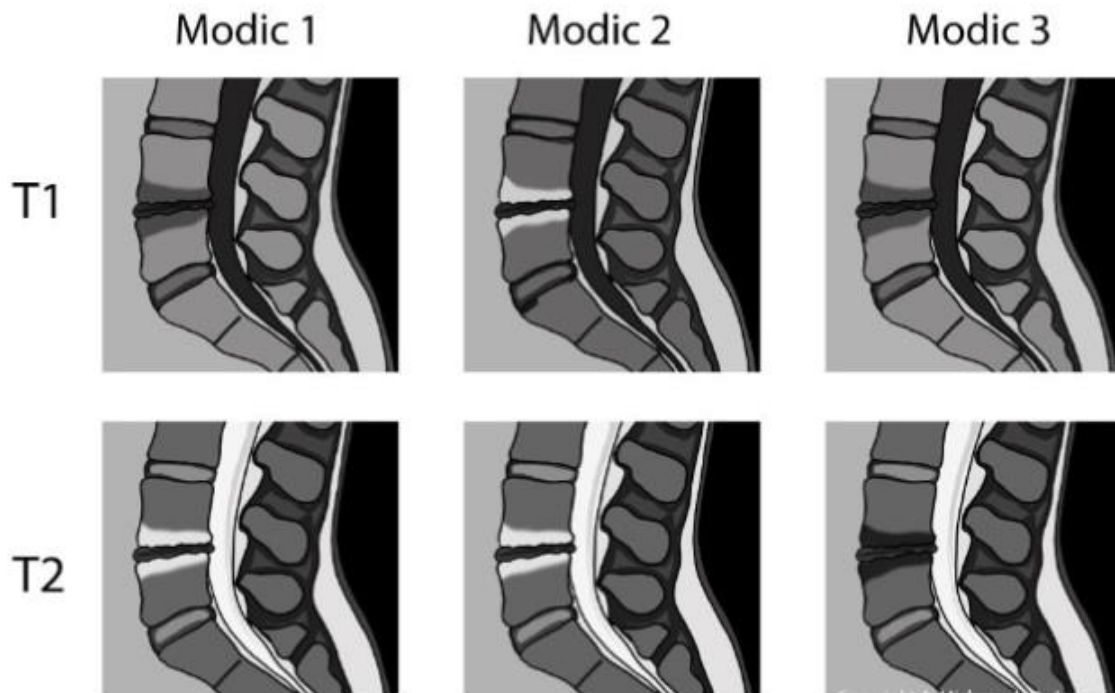
The surgical approach in re-operation was also under discussion. We accepted the SOD as the rightful way to execute. The question – “to fuse the disc or not” should be an object of further discussion in future surveys without financial interests. Surgeons should not forget the basic principles of the spinal biomechanics.

To summarize: the lumbar region of the spine could resist mechanical stress up to 8000 N. The additional “help” of the ligaments and joints convinced us to rely on the natural ability of the lumbar spine to resist on external forces.

Posterior stabilizing procedures are quite trivial at present. Surveys on the Modic MRI changes proved that type I changes of the end plate were not stable, whereas type II changes were more stable. Undertaking the stabilization procedure in both types of Modic changes would be rather hazardous. We preferred the antibiotic treatment in those cases.



# Modic changes



**Fig. 22** MRI Modic changes at the “end plate” zones.

\*Modic changes – MRI signal intensity changes the bone marrow adjacent to the end plate of the degenerative disc.

Modic changes	MR T1 weighted	MR T2 weighted	Signification
<b>Modic 1</b>	Low signal	High signal	Marrow edema
<b>Modic 2</b>	High signal	High signal	Fatty degeneration of subchondral marrow
<b>Modic 3</b>	Low signal	Low signal	Extensive bony sclerosis

**Table 15** Significance of Modic changes.

The appropriate surgical intervention should take the following factors into consideration: present symptoms; CT and MRI data detecting stability/instability; sagittal/frontal deformities, history of previous re-herniations and, finally, the comfort of the surgeon.

Minimally invasive methods didn't seem to be appropriate in re-operations due to limited vision on the field.

*Kim et al.* showed 46% re-operations in the first 6 months after the first surgery. In other studies it was stated that 29-65% of all re-operations happened during the first year after the first surgery. In our survey, the re-operation percentage during the first year was 54%. Recent modern notion was the so called BCD (Barricade Closure Device) – a polyester stopper that obliterated the annular defect. Titanium hooks fixed this “cork” to the adjacent vertebral bodies. In theory, this was meant to preserve the height of the intervertebral space, thus making re-herniation impossible. We assumed that the risk of aseptic instability was greater than the theoretical advantages.

*Krutko A.V.* from Novosibirsk demonstrated this aseptic instability in their clinical survey.



**Fig. 23** CT (a, b) and MRI (c, d) lumbar spine images 1.5 months after surgery. CT images showed bone resorption surrounding the implant (L5-S1 level) and inflammation –

spondylodiscitis. A.V. Krutko et al. (*International Journal of Surgery Case Reports* 24 (2016) 119–123).

Nevertheless, reconstructing the annular fibrous ring was a challenging task that is to be solved in the future.

Herniation relapses were more frequent when minimally invasive methods were used. The reasons for that outcome were the restricted visual area and the two-dimensional outlook of the surgical field. (*Toli et al.*)

No consensus was reached in the literature data if only a curettage of the disc or a sequestrectomy was to be performed.

	<b>Sequestrectomy</b>	<b>Aggressive resection of the disc with curettage</b>
<b>1</b>	Preserves the height of the intervertebral space	Causes a collapse of the intervertebral space
<b>2</b>	Minimal and non-obligatory joint instability	Obligatory joint instability
<b>3</b>	No secondary spondylotic and joint changes	Accelerates the process of spondylosis and joint hypertrophy
<b>Conception:</b>	Preserving the normal disc and end plates prevents the development of secondary changes in the affected zone	The residual disc is highly susceptible to re-herniation

**Table 16** Different concepts for the advantages/disadvantages of both procedures.

The herniated pulpous nucleus is classified by using the Carrage system. In our survey, we followed the rules described below.

LDH type:	Extruded or subannular fragments	Status of the annular ring	Surgical treatment
<b>Type 1: fragment-fissure</b>	YES	A small ring-shaped defect	Extirpation of the fragments through the defect
<b>Type 2: fragment-defect</b>	YES	Large / massive ring-shaped defect	Extirpation of the fragments through the defect
<b>Type 3: fragment – no defect (subannular fragment)</b>	YES	No defect	Ligament and annular ring incision in order to reach the subannular fragments
<b>Type 4: No fragment</b>	NO	No defect	Extensive annulotomy with extirpation of the protruded disc

**Table 17** *Two theories – different concepts*

Type 1 DH proved to have the best post-operative outcome – only 1% of DH relapses, while type 4 had the worst outcome – 38% of all patients had relapses and permanent symptoms.

Having in mind the results described above as well as the constant development of the minimally invasive techniques, an important decision has to be made: which of the many mini-invasive techniques is most appropriate to be given financial support?

Each patient as to be aware that, in a 3-year post-operative period, the possibility of re-herniation is approximately 10%. There is a need for a longer period of follow-up (3-5 years) in order to achieve better precision in the outcome estimation.

- ODI of the surgically treated patients (1-5 years of follow-up) is within 0-20% - minimal dysfunction. Those are statistically significant results achieved from a follow-up of 493 patients during the first and 90 patients on the fifth post-operative years.
- The retrospective study of the conservatively treated patients (by using the VAS criteria) revealed more unfavorable results. The mean VAS decrease was 1.3 points. Surgically treated patients had a VAS decrease of 5.8 points (more than 4 times better). It should be admitted, though, that within the 5-year follow-up the VAS data were rather equalized (2.4 and 3 points, respectfully). Those results were statistically insignificant but it was confirmed that the early effects undoubtedly favor the surgical treatment.

- ANOVA statistics showed significant differences between the mean VAS values in SOD vs MD methods of surgical treatment. We explained this fact with the iatrogenic operative trauma that was more extensive when SOD was performed.

The literature data from the past 30 years and the fulfilled tasks that we had set before ourselves, enabled us to draw the following conclusions:

## **Conclusions:**

1. The classical SOD assures an excellent long term functional outcome (5 years), maximally adequate with the patient's expectations.
  - it must be noted that the Neurosurgery Clinic in Pleven is a well recognized center with experienced spinal surgeons.
2. Early postoperative functional results are undoubtedly more successful in comparison to the conservative treatment.
3. VAS, ODI, MacNaab criteria, Phirman grading system are decisively important for the ongoing investigational process in the field.
4. MD/SOD have no VAS, ODI (1 month) statistical differences.
5. Future prospective randomized investigations are needed for an accurate assessment of the effects of conservative vs. surgical treatment.
6. Implementation of sophisticated minimally invasive techniques and instrumentation (expensive equipment) should be considered very carefully by future prospective investigations with no financial interests.
7. Implementations of the survey:
  - Standard is offered in the medical documents (the chart of the patient).
  - Introduction of the MRI Phirman grading system is helpful for the surgeon in the process of deciding the best treatment option.
  - Estimating the postoperative complications according to the Clavien-Dindo classification renders additional objectiveness of the outcomes.
  - VAS, ODI, MacNaab criteria are mandatory for maximal precision of the postoperative treatment effect.

## **Publications**

Ovcharov M., M. Mladenovski Spondylogenic myelopathy and radiculopathy. Disc degenerative disease. Valkov I, M. Mladenovski editors. The most frequent pathologies in neurosurgery. First edition ISBN 978-954-756-186-1 Publishing center MU-Pleven 2018. p. 224-226

Ovcharov M., M. Mladenovski. Lumbar disc herniation - Epidemiology. Pathogenesis. Clinical symptoms. Examinations. Diagnosis. Differential diagnosis. Treatment. Valkov I, M. Mladenovski editors. The most frequent pathologies in neurosurgery. First edition ISBN 978-954-756-186-1 Publishing center MU-Pleven 2018. p. 226-233

Ovcharov M., I. Valkov, M. Mladenovski, N. Vasilev. Recurrence rate of lumbar disc herniation after standard discectomy and microdiscectomy: A 5-year study. J Biomed Clin Res. 2019, Volume 12 Number 2, 139–146.

Ovcharov M., I. Valkov, M. Mladenovski, N. Vasilev, I Duhlenki. Recurrent lumbar disc herniation. XVIII National congress of Neurosurgery. 04-06 October 2019, Pravetz, Bulgaria.

Ovcharov M. Clinical outcomes after standard discectomy and microdiscectomy for lumbar disc herniation. A single center study. J Biomed Clin Res. 2020, Volume 13 Number 1, 41–7.