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Fusion rate of a PEEK TLIF cage according to the addressed spinal segment - a retrospective analysis

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Abstract

Object: Lumbar Fusion is a successful operative possibility to treat lumbar degenerative diseases. The literature describes fusion rates of 90%. This study investigated the rates of lumbar fusion in two different segments in the lower spine.

Methods: This retrospective study included patients who were treated by transforaminal lumbar interbody fusion (TLIF) from 2009-2012 in the orthopaedic and trauma surgery at St. Marienkrankenhaus hospital in Ludwigshafen. The fusion rate of 48 Segments and the correlation between fusion und segment were radiographically examined. The clinical outcome was measured from 39 patients by VAS and ODI and was compared with the fusion rate.

Results: The fusion rate in L3/4 was 33,3% and in L4/5 15,2%. There was no correlation between fusion and segment. The clinical evaluation showed an average improvement in VAS of 4,5. The ODI showed an average improvement of 31,1%. There was a significant difference between preoperative VAS and ODI to follow-up. The clinical outcome compared to the fusion showed no significant deviation.

Conclusion: This study didn't find a difference between the fusion rates in L3/4 or L4/5. The pseudarthrosis rate was very high, but good clinical outcomes could be observed so it seems that stable pseudarthrosis after lumbar fusion is sufficient to reduce pain.

Introduction

In 1982 Harms and Rolinger [1] described the transforaminal lumbar intercorporal fusion (TLIF) for the treatment of spondylolisthesis. Since 1998 it has been used for lumbar degenerative diseases [2-5]. The aims are the same as for all other types of lumbar fusion: reduction of the lumbar pain with or without radicular symptoms by nerve decompression and rebuilding the segmental stabilization and the intervertebral disc height [1,5-13].

There are a lot of studies that describe a good clinical outcome when intervertebral fusion is done [7,12-20]. Lumbar fusion is defined as a radiographic bridge bone between the both adjacent vertebral bodies. Many reasons and conditions that seems to improve the fusion rate are known [7-10,19,21-36]. The anatomy and biomechanics in each spinal segment is different. To our knowledge there are no published reports that investigated if there is a difference in fusion according to the addressed segment. This study compared the fusion rates in L3/4 and L4/5 and the clinical outcome after fusion.

Materials and methods

This retrospective study included patients who were treated by transforaminal lumbar interbody fusion from 2009-2012 in the orthopaedic and trauma surgery at St. Marienkrankenhaus hospital in Ludwigshafen by the chief physician and two senior physicians. The indications for the surgery were symptomatic degenerative lumbar diseases. Other inclusion criteria were the minimum age of 18 years, the use of PEEK cage type 'Mobis I' from Signus Medizintechnik GmbH (Alzenau) in Germany and a follow up radiography at least one year after surgery. The surgical technique was based on the publication by Harms and Jeszenszky [5] in 1998. The surgeons used local autografts for the interbody fusion. In contrast to Harms [5] they did no posterolateral fusion and performed distraction through the facet screws. All posterior instrumentation was done with several pedicle screw systems, all polyaxial and titanium rods.

The fusion rate of 48 Segments (Group R1: L3/4 = 15, Group R2: L4/5 = 33) were radiographically examined with an own created evaluation sheet by one senior physician and a PhD student separately. When they had different fusion results they reached a consense.

The fusion criteria were based on Abbushi [21] and McAffee [14] and included:

- Bone bridge between the both adjacent vertebral bodies in- and/or outside the cage
- No osteolysis around the cage or of the bone inside the cage
- No sagittal motion in lateral flexion-extension radiographs > 3°
- No cage migration
- No screw loosening

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No interbody fusion was defined as no bone bridge between the both adjacent vertebral bodies in- and/or outside the cage, segmental instability or cage migration. But many patients had no bone bridge but also no sagittal motion in the flexion-extension radiographs and no migration of the cage. We defined this as non-fusion, but stable pseudarthrosis.

The clinical outcome preoperative and in the follow up was measured from 39 patients by VAS and ODI and were compared. According to their fusion result they were divided in three groups:

- Group C1: in every segment fusion (n = 8)
- Group C2: No Fusion in one or both segments (n = 9)
- Group C3: No Fusion in one or both segments but stable pseudarthrosis (n = 22)

The demography of all groups is shown in table 1 and 2 (Figure 1).

Results

Perioperative complications were found in 7 (17,5 %) cases: damage of the anterior ligament (n = 1), lack location of the screws (n = 2), wrong intraoperative placement of the cage (n = 2), intraoperative cage-breaking in the bone (n = 1), dural leak with intraoperative cage-breaking in the bone (n =1). Two patients had no postoperative radiographies, so cage migration was just assessed in 46 segments. Cage-breaking to caudal or cranial was found in 28 segments (60,9%), cage dislocation to anterior or posterior was found in 11 segments (23,9%) and cage rotation to right or left was found in 14 segments (29,2%). There were screw loosening in 7 segments (14,6%) postoperative (Figures 2 and 3).

For the comparison of fusion rate between L3/4 and L4/5 48 segments from 40 patients were examined: L3/4 (n = 7), L4/5 (n = 25) and L3-5 (n = 8). The fusion rate in L3/4 was 5 from 15 segments (33,3%) and in L4/5 5 from 33 segments (15,2%) (Table 3). We found no correlation between fusion and segment. The Odds Ratio (OR = 0,36) showed that the chance for fusion in L4/5 is smaller than in L3/4.

The clinical evaluation showed an average improvement in VAS of 4,5 (6,6-8,1 preoperative to 2,5-2,9 in the follow-up). The ODI showed an average improvement of 31,1% (52,9-42,2% to 19,2-14,8%). There was a significant difference between preoperative VAS and ODI to follow-up. The clinical outcome compared to the fusion rate of the groups C1-3 (fusion, non-fusion, non-fusion but stable pseudarthrosis) showed no significant deviation.

Table 1. Demographics of the patients for radiographic examination

	Average	SD*[1]	Minimum	Median	Maximum
Group R1 (n = 15) **m = 8** **w = 7**					
Age at surgery (years)	67,7	8,4	51	69	82
Time from surgery to radiographic examination (months)	24,8	9,5	12	23	45
Group R2 (n = 33) **m = 18** **w = 15**					
Age at surgery (years)	67,5	6,6	53	68	77
Time from surgery to radiographic examination (months)	28,7	10,2	14	29	47

*[1]SD: Standard Deviation

Table 2. Demographics of the patients for the clinical examination

	Average	SD[1]	Minimum	Median	Maximum
Group C1 (n = 8) **m = 4** **w = 4**					
Age at surgery (years)	64,3	7,3	51	65	75
Time from surgery to clinical examination (months)	25,1	10,6	13	20,5	46
Time from surgery to radiographic examination (months)	25,4	10,7	13	21	46
Group C2 (n=9) **m = 6** **w = 3**					
Age at surgery (years)	69,3	6,4	54	73	75
Time from surgery to clinical examination (months)	28,2	9,2	14	30	42
Time from surgery to radiographic examination (months)	28,3	9,2	14	31	42
Group C3 (n=22) **m = 10** **w = 12**					
Age at surgery (years)	67,3	8	52	68,5	82
Time from surgery to clinical examination (months)	26,5	10,6	12	25	47
Time from surgery to radiographic examination (months)	27,4	10,9	12	25	47

Table 3. Fusion rates

Segment	Number of Segments	non-Fusion	Fusion	Odds Ratio	*p*-value
L3/4	15	10 (66,7 %)	5 (33,3 %)	Ref.	
L4/5	33	28 (84,8 %)	5 (15,2 %)	0,36 (0,08-1,57)	
total	48	38 (79,2 %)	10 (20,8 %)	-	0,249

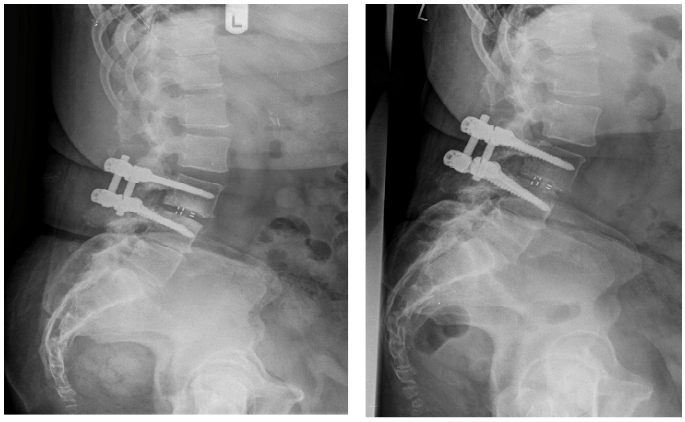

Figure 1. Left post-operative after surgery; right at least one year after surgery

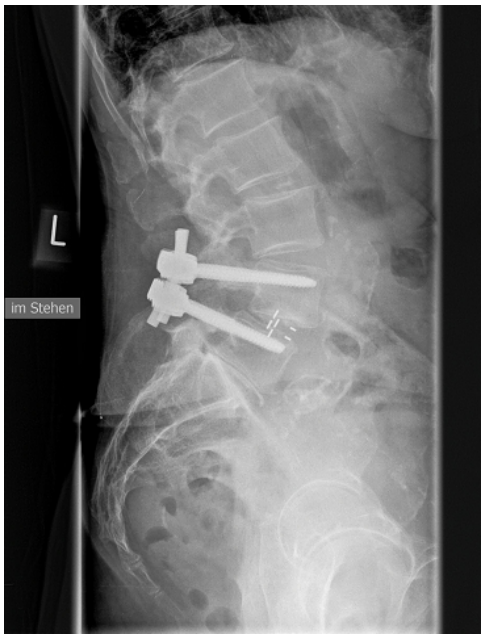

Figure 2. Cage breaking in the F/U radiography

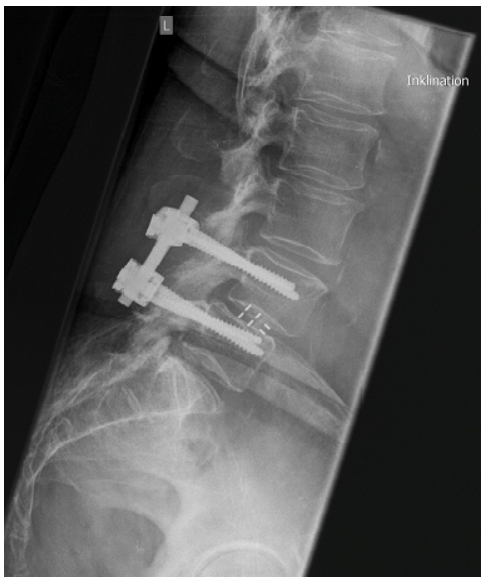

Figure 3. Screw loosening in the upper screws

Group C1 and Group C3 was also compared. There was no significant difference between the clinical outcome.

Discussion

The diverse lordosis in each segment and the gravity are responsible for the different anatomy and biomechanics in the spine. Lumbar fusion helps to improve the pain and the clinical outcome [7,12-20]. It is necessary to know all the reasons and conditions that enhance the probability for interbody fusion. This study investigated if there is a difference in fusion according to the addressed segment. We found no significant difference between the segment L3/4 or L4/5 in fusion rate. But the total fusion rate was just 20,8%. Compared to other studies this is very low. The literature describes fusion rates of 90 % [2-4,7,8,18-20,22,23,25,37-44]. So, it's difficult to make an adequate statement if the segment is a factor for reaching interbody fusion.

A meaningful reason for the low fusion rate was the limited patient rate of the study, especially for the L3/4 group. We didn't evaluate co-factors like diabetes, NSAR-taking, smoking, spondylodiscitis, rheumatoid arthritis, preceded fusion and/or revisions [7,10,24-31]. The patient population was inhomogeneous. Another factor that assist a lower fusion rate is the age of the patients, results in lower bone mineralization and higher comorbidities [7,8,32-36]. The age in this study was 67,7 ± 8,4 years (L3/4) and 67,5 ± 6,6 (L4/5) years. Wu et al. [2] had an average age of 48,7 years.

The TLIF-surgeries in this study were the first in the surgeon's career. Maybe in the beginning they didn't realize the optimal technique. For example, it is important to remove the whole disc [45] and do sufficient decortication [7-9,19,22,23].

The surgeons just used local spongiosa to refill the PEEK cages. They didn't use tricalcium phosphonate, bmp's or AGF's. But there is no evidence that the use of this materials promises a better fusion rate [23,44].

The most important factor for the low fusion rate in this study was apparently the strict fusion criteria. The fusion criteria differ depending on the study so the comparison with other studies is very difficult [2,21,46,47]. This study used the criteria of Abbushi et al. [21] and McAffee et al. [14] and defined a stable pseudarthrosis.

Lumbar interbody fusion helps to reduce pain [7,12-20]. In this study the fusion rate was very low, but 87,2% showed an improved clinical outcome. There was no significant difference between the fusion rate and the clinical outcome. It was very noticeable that the pseudarthrosis rate was 56,4%. Other studies have shown a rate of 2-10% [5,17,20,43,48].

Conclusion

This study didn't find a difference between the fusion rates in L3/4 or L4/5. There was a smaller chance for reaching interbody fusion in L4/5 than in L3/4. Many reasons could influence the fusion rate. There is no standard for analysing interbody fusion. Very strict criteria were used and definition of a stable pseudarthrosis was done. This pseudarthrosis rate was very high, but good clinical outcomes could be observed, so it seems that stable pseudarthrosis after lumbar fusion is sufficient to reduce pain [49-51]. A mass of fibrocartilaginous tissues in- and outside the cage is obviously sufficient instead of interbody bone bridging to improve pain [52-54].

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