



Study on Outcome Analysis of Transforaminal Interbody Fusion with Transpedicular Screws and Rods in Lumbar Spondylolisthesis and Spondylolysis

Estudo sobre análise de resultados de fusão intersomática transforaminal com parafusos e hastes transpediculares na espondilolistese e espondilólise lombar

Prakash Mahantshetti¹ Prasad Soraganvi² Rayadurg Palegar Raghavendra Raju³

¹ Department of Neurosurgery, Jawaharlal Nehru Medical College, Belgaum, Karnataka, India

² Department of Orthopedics, P.E.S. Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India

³ Department of Orthopedics, MS Naidu Hospital, Vijayawada, Andhra Pradesh, India

Address for correspondence Prakash Mahantshetti, MS, MCh, Department of Neurosurgery, JN Medical College: Jawaharlal Nehru Medical College, R.C Nagar 2nd stage Belagavi, Karnataka- 590006, India (e-mail: drprakashsm@gmail.com).

Arq Bras Neurocir 2022;41(4):e335–e339.

Abstract

Introduction The management of spondylolisthesis and spondylolysis is primarily conservative or surgical. There are various surgical procedures available for spondylolisthesis.

Objective To evaluate the functional outcome and efficacy in patients undergoing transforaminal lumbar interbody fusion with transpedicular screws and rods in symptomatic lumbar spondylolisthesis and spondylolysis.

Methods From 2017 to 2018, a prospective observational study was performed in a tertiary care hospital. The preoperative evaluation was performed both clinically and radiologically. Based on indications, transforaminal interbody fusion was performed. A total sample of 20 patients was included. The primary outcome variables were the visual analogue scale (VAS), the Oswestry Disability Index (ODI), slip percentage, and disc height at follow-up. For the statistical analysis, coGuide (BDSS CORP, Bangalore, Karnataka, India) was used.

Results In 20 participants studied, the mean age was 48.25 ± 5.35 years old. Degenerative spondylolisthesis was seen in 60% of the participants. The majority (70%) of the patients had grade 2 slips. The mean difference of the VAS, the ODI, slip

Keywords

- ▶ spondylolisthesis
- ▶ spondylolysis
- ▶ intervertebral disc degeneration

received
May 30, 2021
accepted
September 6, 2021

DOI <https://doi.org/10.1055/s-0041-1740167>.
ISSN 0103-5355.

© 2022. Sociedade Brasileira de Neurocirurgia. All rights reserved. This is an open access article published by Thieme under the terms of the Creative Commons Attribution-NonDerivative-NonCommercial-License, permitting copying and reproduction so long as the original work is given appropriate credit. Contents may not be used for commercial purposes, or adapted, remixed, transformed or built upon. (<https://creativecommons.org/licenses/by-nc-nd/4.0/>)
Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

percentage, and disc height between the preoperative and postoperative periods was statistically significant ($p < 0.001$). The majority (70%) of the patients had no complications after the procedure.

Conclusions Transforaminal interbody fusion with pedicle screws and rods is a safe, simple procedure and has less morbidity. This procedure also provides better functional outcomes and reduction in symptoms by maintaining the disc height and providing sagittal balance.

Resumo

Introdução O tratamento da espondilolistese e espondilólise é principalmente conservador ou cirúrgico. Existem vários procedimentos cirúrgicos disponíveis para espondilolistese.

Objetivo Avaliar o resultado funcional e a eficácia em pacientes submetidos a fusão intersomática lombar transforaminal com parafusos e hastas transpediculares em espondilolistese e espondilólise lombar sintomática.

Métodos De 2017 a 2018, foi realizado um estudo observacional prospectivo em um hospital terciário. A avaliação pré-operatória foi feita clínica e radiologicamente. Com base nas indicações, a fusão intersomática transforaminal foi feita. Uma amostra total de 20 pacientes foi incluída. As variáveis de desfecho primárias foram a escala visual analógica (EVA), o Oswestry Disability Index (ODI, na sigla em inglês), porcentagem de escorregamento e altura do disco no acompanhamento. Para análise estatística, foi utilizado o coGuide (BDSS CORP, Bangalore, Karnataka, Índia).

Resultados Nos 20 participantes estudados, a média de idade foi de $48,25 \pm 5,35$ anos. Espondilolistese degenerativa foi observada em 60% dos participantes. A maioria (70%) dos pacientes apresentou deslizamentos de grau 2. A diferença média da EVA, do ODI, da porcentagem de escorregamento e da altura do disco entre os períodos pré- e pós-operatório foi estatisticamente significativa ($p < 0,001$). A maioria (70%) dos pacientes não apresentou complicações após o procedimento.

Conclusões A fusão intersomática transforaminal com parafusos pediculares e hastas é um procedimento seguro, simples e de menor morbidade. Este procedimento também fornece melhores resultados funcionais e redução dos sintomas, mantendo a altura do disco e proporcionando equilíbrio sagital.

Palavras-chave

- ▶ espondilolistese
- ▶ espondilólise
- ▶ degeneração do disco intervertebral

Introduction

In the evolution of humans to an upright posture, human beings have developed a pelvis system that acts as a key structure within the locomotor system. During the course of human development, various developmental modifications have happened around the skeleton of the pelvis. These developments have also increased the susceptibility to degeneration.¹ Spondylolisthesis is one such degenerative condition that occurs due to the forward slippage of the cephalad vertebra on a caudal vertebra.² It is one of the common causes of lower back pain in the adult population. The treatment of the symptomatic cases is either conservative or surgical.³ Bone healing, pain relief, and optimization of physical activity are the three major objectives of the management modality. Various surgical interventions are available for management, such as posterior lumbar interbody fusion (PLIF) and anterior lumbar interbody fusion (ALIF).^{4,5} In 1982, a technique devised by Harms et al. was termed transforaminal lumbar interbody fusion (TLIF), in which a

bone graft filled in a titanium cage was inserted through the transforaminal route.⁶ Transforaminal lumbar interbody fusion is one such technique in which the anterior and posterior columns are fused through a posterior approach. The anterior segment is stabilized using a bone graft and spacer, whereas the posterior segment is stabilized using rods, pedicle screws, and bone graft.² The main advantage of this technique is that it restores the disc space and maintains the lumbar lordosis and sagittal balance. It provides another advantage of conserving the posterior segment on the opposite side, thereby increasing the surface area for laminal fusion. When compared with other surgical techniques, TLIF has lesser nerve and dual damage and also provides better fusion.⁷ In a study by Balasubramanian et al., clinical and radiological correlations were performed and the study showed that 85% of the participants showed good clinical outcome at the end of 1 year.⁸ Previously available literature has shown that symptomatic lumbar spondylolisthesis and spondylolysis can be efficiently managed by TLIF.^{5,7,9,10} There is a gap in the available literature regarding the

functional outcome of the patient in the postoperative period. Hence, the present study was planned to fill in this gap. The present study was performed to evaluate the functional outcome in symptomatic lumbar spondylolisthesis and spondylolysis patients treated by TLIF using transpedicular screws and rods.

Materials and Methods

In a tertiary care hospital, a prospective observational study was performed from 2017 to 2018. Twenty participants were enrolled in the study. Informed written consent forms were signed and baseline clinical examination was done. Clearance of the institutional ethical committee was obtained prior to the start of the study. Data confidentiality was maintained. Baseline clinical and radiological evaluations were done. Patients who had intractable pain, progressive slip, slip $\geq 25\%$ on presentation, neurological deficit-claudication, significant gait disturbance, cosmetic or postural disturbance, and significant motion in dynamic X-rays were taken up for transforaminal interbody fusion. Patients > 20 years old with isolated symptomatic lumbar spondylolisthesis of any grade with or without spinal canal stenosis, as well as patients who were willing to undergo surgery were included in the study. Patients with severe osteoporosis and vertebral pathologies were excluded.

The sample size was calculated with the assumption of an expected mean difference in the outcome before and after intervention of 5.3 and a standard deviation of 4.5 according to the previous study by Reddy et al.¹ The power of the study was kept at 90% with a 5% two-sided α error. The sample size was determined by using the formula as proposed by Kirkwood et al.¹¹ The required sample size, according to the aforementioned calculation, was 16. To make up for a nonparticipation rate of $\sim 30\%$, 3 participants were added to the sample size. Hence, the total sample size was 19 subjects.

Both anteroposterior and lateral films were taken. When slippage or pars defect was not clear, oblique (45° angled) radiographs were taken. In high-grade spondylolisthesis, the slippage appears as 'inverted Napoleon's hat', and in pars defect, the 'Scottie dog' pattern is seen.

Transpedicular Screw Placement

For the entry point into the lumbar pedicle, the Roy-Camille technique was used. In the Roy-Camille method, the location of the entry point is by the intersection of the midtransverse process line and the superior facet midline. These bony landmarks are easily identified during surgery. The entry points were identified under C-Arm guidance, and screws were placed through the pedicle into the body. Monoaxial and polyaxial screws were used for instrumentation. Sacral screws were placed parallel to the sacral endplate with bicortical purchase. Unilateral laminectomy and unilateral facetectomy were performed. Using an intervertebral distractor and a nerve root distractor, the disc was approached through the transforaminal route, and complete discectomy was performed. Endplates were thoroughly scraped. The

adequate reduction was attempted by distraction after placing the titanium rod, and the upper body was moved in a cranial and posterior direction by rotatory movements. The spinous process and lamina bone graft were made into small pieces and placed in the interbody space so that they fit snugly in the titanium cages placed in the interbody space. The closure was performed in multiple layers—paraspinal muscle fascia and subcutaneous tissue with Vicryl and skin with Ethilon under a negative suction drain. The preoperative and postoperative comparison was made of the various study parameters.

The visual analogue scale (VAS) and the Oswestry Disability Index (ODI) were the primary outcome measures used. Preoperative measurements were corroborated with postoperative measurements and compared with the effectiveness of the surgery.

Statistical Methods

The primary outcome variables were the VAS, the ODI, slip percentage, and disc height at follow-up. Age, gender, duration of symptoms, complications, etc., were kept as other relevant variables. The description of the data was represented by mean and standard deviation (SD). Statistical significance was considered with $p < 0.05$. coGuide (BDSS CORP, Bangalore, Karnataka, India) version V.1.0 statistical software was used.

Results

Twenty patients were included for the final analysis.

Among the study subjects, the mean age was 48.25 ± 5.35 years old, ranging from 22–59 years old. Regarding the duration of symptoms, 11 (55%) patients had symptoms for < 36 months and 9 (45%) of them had symptoms for ≥ 36 months; 20 (100%) of them had lower back pain, 14 (70%) had radiculopathy, 7 (35%) had claudication, and 11 (55%) had comorbid conditions. Regarding the level of slippage, 11 (55%) had L5-S1, and 9 (45%) had L4-L5. Regarding the grade of slippage, 14 (70%) had grade 2, and 5 (25%) had grade 3 (**► Table 1**).

Among the study population, the mean preoperative VAS score was 7.50 ± 1.05 , and the mean postoperative VAS score was 2.20 ± 1.19 . The mean difference in the VAS score between the two periods was statistically significant, ($p < 0.001$). The mean difference for ODI, slip percentage, and disc height between the two periods was statistically significant, with a high preoperative ODI of 59.11 ± 8.65 compared with a postoperative ODI of 33.10 ± 9.69 ($p < 0.001$). (**► Table 2**).

Discussion

The most common spondylolisthesis type among the study participants was degenerative. Although many procedures exist for the management of spondylolisthesis, achieving disc stability and postoperative pain reduction is the main aim of performing a procedure. Transpedicular screw fixation with interbody fusion is one of the procedures with advantages such as high fusion rate, early postoperative mobilization of

Table 1 Descriptive analysis of baseline parameters in the study population ($n = 20$)

Parameter	Summary statistics
Age (years old)	48.25 ± 5.35 (22–59)
Age (years old)	
30–40	01 (5%)
41–50	10 (50%)
51–60	09 (45%)
Gender	
Male	09 (45%)
Female	11 (55%)
Type of spondylolisthesis	
Degenerative	12 (60%)
Isthmic	7 (35%)
Traumatic	1 (05%)
Duration of symptoms (months)	
< 36 months	11 (55%)
≥ 36 months	9 (45%)
Lower back pain - present	20 (100%)
Radiculopathy - present	14 (70%)
Claudication - present	7 (35%)
Comorbid conditions - present	11 (55%)
Level of slip	
L4-L5	09 (45%)
L5-S1	11 (55%)
Grades of slip	
Grade 1	01 (5%)
Grade 2	14 (70%)
Grade 3	05 (25%)
Spacer	
Bone graft	15 (75%)
Titanium cage	05 (25%)
Fusion	
Fusion	18 (90%)
Pseudo arthroses	02 (10%)
Rate of fusion	4.85 ± 2.05 (1–8)
Complications	
Implant related	01 (5%)
Infection	02 (10%)
Others	03 (15%)
No complications	14 (70%)

the patient, and lack of need for orthoses postoperatively.¹ The foremost findings of the present study were that the mean difference in the VAS between the preoperative and postoperative periods was statistically significant ($p < 0.001$), and that the mean difference in the ODI, slip percentage, and disc height

Table 2 Comparison of outcome parameters between the preoperative and postoperative periods ($n = 20$)

Parameter	Periods		p-value
	Preoperative	Postoperative	
VAS	7.50 ± 1.05	2.20 ± 1.19	< 0.001
ODI	59.11 ± 8.65	33.10 ± 9.69	< 0.001
Slip percentage	44.65 ± 15.01	18.75 ± 7.52	< 0.001
Disc height	8.96 ± 0.17	10.69 ± 0.18	< 0.001

Abbreviations: ODI, Oswestry Disability Index; VAS, visual analogue scale.

between the preoperative and postoperative period were also statistically significant ($p < 0.001$).

In the present study, most prevalent age group ranged from 41 to 50 years old. Degenerative spondylolisthesis was the most common among the study participants. Similar findings were observed by Reddy et al.¹ in whose study the most commonly affected group was in the range between 40 and 50 years old. In the present study, the most common type of spondylolisthesis was degenerative, followed by isthmic and traumatic. Similar findings were also observed by Soren et al.,⁹ in whose study 62.4% of the participants had degenerative spondylolisthesis. In the present study, 55% of the participants had a level of slippage at L5-S1. A similar level of slippage was observed by Vekatesh et al.¹ and Kalichman et al.¹⁰ In these two studies, the slippage level at L5-S1 was due to degenerative spondylolisthesis, whereas in isthmic listhesis the slippage level L4-L5. Invariably, all participants of the present study had lower back pain, similar to other studies.^{13,14} In a study by Möller et al.,¹⁵ 62% of the study participants had lower back pain with sciatica. Most commonly, spondylolisthesis presents with two types of symptoms. The back symptoms, like lower back pain, are caused due to mechanical pain, and the patient will feel better with fixation, whereas the leg symptoms, such as sciatica, tingling, and numbness caused due to nerve compression, will respond well to a decompression procedure. Ironically, the back pain of the spondylolisthesis disappears once there occurs spontaneous fusion of the spondylolisthesis segment. The leg symptoms associated with spondylolisthesis is caused due to canal compromise caused due to disc prolapse and also due to ligamentum flavum hypertrophy. The relief of these symptoms can be achieved by wide decompression. In all study participants, wide laminectomy and discectomy were performed to achieve adequate decompression.

Despite the available evidence, the management of lumbar spondylolisthesis remains controversial due to lack of absolute success by any single modality. There are several other techniques, such as anterior interbody fusion (ALIF), extreme lateral interbody fusion (XLIF), and posterolumbar interbody fusion (PLIF). Achieving symptomatic relief from pain, removal of neurological defects, and improving stability remains the main objectives of treatment. Transforaminal lumbar interbody fusion with transpedicular screws and rods has been successful in producing a functional outcome postoperatively. In the

present study, there was a statistically significant difference in the VAS, the ODI, slip percentage, and disc height in the preoperative and postoperative periods. This indicates that the operative procedure has addressed the aforementioned objectives. Similar efficacy and functional outcomes have been documented in previous literature.^{1,2,13,14} The present adds evidence to support that TLIF with transpedicular screws and rods provides the best functional outcome.

The limitation of the present study was that it was based on a small sample from a single center. Multicentric studies comparing the efficacy of other treatment modalities in the management of spondylolisthesis and spondylolysis are recommended in the future.

Conclusion

Transformational interbody lumbar fusion with transpedicular screws and rods is a safe and effective management option for degenerative spondylolisthesis and spondylolysis. It provides a good functional outcome through pain relief and improves quality of life.

Conflict of Interests

The authors have no conflict of interests to declare.

Acknowledgments

We acknowledge the technical support in data entry, analysis and manuscript editing by "Evidencian Research Associates."

References

- Reddy VVR, Chathrapathi H, Amar J. Functional outcome analysis of transforaminal lumbar interbody fusion using transpedicle screws and rods in the management of symptomatic lumbar spondylolisthesis and spondylolysis. *Int J Sci Res* 2020;9:40-43
- Premkumar DT, Thirumalaimurugan DP. A study on functional outcome of transforaminal lumbar interbody fusion in spondylolisthesis. *Int J Orthop Sci.* 2018;4:637-643
- Beutler WJ, Fredrickson BE, Murtland A, Sweeney CA, Grant WD, Baker D. The natural history of spondylolysis and spondylolisthesis: 45-year follow-up evaluation. *Spine (Phila Pa 1976)* 2003;28(10):1027-1035, Discussion 1035
- Schnee CL, Freese A, Ansell LV. Outcome analysis for adults with spondylolisthesis treated with posterolateral fusion and transpedicular screw fixation. *J Neurosurg* 1997;86(01):56-63
- Zdeblick TA. A prospective, randomized study of lumbar fusion. Preliminary results. *Spine* 1993;18(08):983-991
- Harms J, Rolinger H. [A one-stager procedure in operative treatment of spondylolistheses: dorsal traction-reposition and anterior fusion (author's transl)]. *Z Orthop Ihre Grenzgeb* 1982;120(03):343-347
- Dehoux E, Fourati E, Madi K, Reddy B, Segal P. Posterolateral versus interbody fusion in isthmic spondylolisthesis: functional results in 52 cases with a minimum follow-up of 6 years. *Acta Orthop Belg* 2004;70(06):578-582
- Balasubramanian VA, Douraiswami B, Subramani S. Outcome of transforaminal lumbar interbody fusion in spondylolisthesis-A clinico-radiological correlation. *J Orthop* 2018;15(02): 359-362
- Soren A, Waugh TR. Spondylolisthesis and related disorders. A correlative study of 105 patients. *Clin Orthop Relat Res* 1985; (193):171-177
- Kalichman L, Kim DH, Li L, Guerhazi A, Berkin V, Hunter DJ. Spondylolysis and spondylolisthesis: prevalence and association with low back pain in the adult community-based population. *Spine* 2009;34(02):199-205
- BR K. *Essentials of medical statistics*. 2 ed. London: Blackwell Scientific Publications; 1988:1-513 p.
- Venkatesh , Chathrapathi HAJ, R R V. Functional outcome analysis of transforaminal lumbar interbody fusion using transpedicle screws and rods in the management of symptomatic lumbar spondylolisthesis and spondylolysis. *Int J Sci Res* 2020; 9:40-43
- Yan DL, Pei FX, Li J, Soo CL. Comparative study of PILF and TLIF treatment in adult degenerative spondylolisthesis. *Eur Spine J* 2008;17(10):1311-1316
- Yehya A. Tlif Versus Plif In Management Of Low Grade Spondylolisthesis. *Alex J Med* 2010;46:127-134
- Möller H, Hedlund R. Instrumented and noninstrumented posterolateral fusion in adult spondylolisthesis—a prospective randomized study: part 2. *Spine* 2000;25(13):1716-1721