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"OUTCOME OF SHORT SEGMENT FIXATION WITH PEDICLE SCREWS, AND INTERLAMINAR FUSION WITH AUTOLOGOUS BONE GRAFT"

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ABSTRACT: *Background: Spondylolisthesis is a slip of all or part of a vertebra forward on another. Gravity and muscle action apply a caudal force on the lower lumbar vertebrae, which is counteracted by the superior and inferior facets, pedicles, posterior arch and intervertebral disc. Short segment fixation is an established technique for Spondylolisthesis of the lumbar spine. Objective: To assess the Outcome of Short Segment Fixation with Pedicle Screws, And Interlaminar Fusion with Autologous Bone Graft. Methods: The present case-control study was conducted in the Department of ortho & Spine Surgery, National Institute of Traumatology & Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh over a period of one year between January 2019 to February 2020. 17 patients with Spondylolisthesis L4-L5 or L5- S1 were operated with short segment fixation with pedicle screws and interlaminar fusion with autologous bone graft. The follow up duration was for 6 months. Results: The mean percentage of slip improved from 29.4% preoperatively to 9.60% at 6 months. The mean Denis pain score and Denis work score improved from 3.95 and 3.95 preoperatively to 1.95 and 1.95 respectively at 6 months. At last follow up, superficial infection had occurred in 1 patient. There was no implant failure or neurological deterioration. Conclusion: Short segment fixation in spondylolisthesis using pedicle screws and interlaminar fusion with autologous bone grafting leads to improved clinical and radiological outcome in patients who have failed to get relieved by conservative therapy. The procedure leads to relief of pain and ability to resume previous work.*

KEYWORDS: short segment fixation, pedicle screws, interlaminar fusion.

INTRODUCTION

Short segment fixation is an established technique for Spondylolisthesis of the lumbar spine. Derived from the Greek "spondylo" meaning vertebra, and "olisthesis" meaning to slip or slide down an incline[1], Spondylolisthesis is a slip of all or part of a vertebra forward on another. Gravity and muscle action apply a caudal force on the lower lumbar vertebrae, which is counteracted by the superior and inferior facets, pedicles, posterior arch and intervertebral disc. Failure of one or more of these structures leads to the forward slippage of the vertebra[2]. Wiltse, Newman and Macnab classified Spondylolisthesis into Dysplastic, Isthmic, Degenerative, Traumatic and Pathological types[3,4,5]. The most common presenting symptom is pain, typically a steady ache related to position or posture, suggesting a mechanical component in the cause of pain; aggravated by activity and relieved on rest. More significant symptoms may arise with the development of spinal stenosis. Incidence of disc degeneration in spondylolisthetic patients in the age group of 25-45 is 70%. Torsion and shear forces on the intervertebral disc are increased in spondylolisthesis, leading to accelerated degeneration[6]. The diagnosis is mainly based on plain radiographs. Lateral view X-ray is most sensitive for viewing anterior slippage of vertebra[7,8]. MRI offers superior imaging of soft tissue of spine and allows evaluation of pars interarticularis[9,10]. For patients with no neurological compromise or chronic stable deficit, treatment is conservative. This includes NSAIDS and multimodal approach such as combining drugs with an exercise programme that includes stretching and strengthening components. If symptoms of pain or neurologic deficit significantly disrupt lifestyle and do not improve with conservative treatment, surgical intervention should be considered. Early surgery may prevent more difficult or risky surgeries at a later time. Surgery can be through a dorsal or a ventral approach. The advantage of ventral approach are complete removal of disc space and large cancellous bony surface available for interbody fusion[11]. Bone grafting added with internal fixation provides higher fusion rates. But the ventral approach limits visualisation of nerve roots and increases possibility of complications such as impotence, ureteral injury and vascular injury[12]. High rates of non-union have also been reported for ventral body fusion. The Dorsal approach has lower morbidity[13] and fusion is possible through posterior approach or posterolateral approach. Compared with posterolateral fusion, interlaminar fusion has the advantages of less operative time, less damage to the paraspinous muscles and less blood loss[14]. Pedicle screw fixation is considered superior to other forms of internal fixation for lumbar spine. It provides fixation with preservation of lumbar lordosis and provides highly successful arthrodesis even in cases of prior pseudoarthrosis[15]. Studies on short segment fixation and interlaminar fusion for spondylolisthesis are lacking. Therefore, this study has been done to see the clinicoradiological outcome using short segment fixation with pedicle screws, and interlaminar fusion with autologous bone graft.

MATERIALS AND METHODS

The present case-control study was conducted in the Department of ortho & Spine Surgery, National Institute of Traumatology & Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh over a period of one year between January 2019 to February 2020. 17 patients with

Spondylolisthesis, who were admitted in the department. Short segment fixation with pedicle screws and interlaminar fusion with autologous bone graft was performed. Patients followed up for 6 months and clinic-radiological outcome was noted. Inclusion criteria was symptomatic cases of Spondylolisthesis aged 20-60 years who were unrelieved by conservative management. We excluded asymptomatic cases, patients with severe osteoporosis, patient with co-morbid conditions contraindicating surgery and patients not consenting to the surgery.

Detailed clinical history and thorough physical examination was done for each patient. Pain status was documented using Denis et al scale. Disability or work status was determined by Denis et al work scale. Radiographs taken included anteroposterior and lateral view of the lumbar spine, standing lateral view, flexion and extension views and an oblique view. Radiographs were analysed. MRI of the involved spinal segment was done to know the status of cord, disc and nerve root. Investigations required for pre-anaesthetic checkup were carried out. Prophylactic antibiotics were started in all the cases six hours before surgery.

All surgical procedures were performed under general anesthesia with endotracheal intubation, with the patients placed in prone position on the operating table. A posterior midline approach was used. The position of the four pedicles of the involved vertebra i.e either L4 and L5 or L5 and S1 were identified and confirmed by image intensifier. A probe was then used to enter the pedicle under C-arm control. Once the pedicle screw track was created, it was sounded, markers were placed and radiographs were obtained in both the AP and lateral planes to confirm proper positioning. The length of pedicle screw was confirmed by use of the depth gauge. Pedicle screws of appropriate diameter (usually 4.5 mm) were inserted into the involved vertebrae. After insertion of screws, hemilaminectomy was performed on the side of maximum compression to decompress the cord. In cases of bilateral compression, both sides were decompressed. Rods with appropriate length were contoured and inserted into the end screw extender sleeves. Reduction achieved in process of distraction was accepted and no further attempts at reduction were done (Figure 1). Interlaminar fusion was done with autologous bone graft and incision was closed in layers over drain.
Log rolling every 2 hours was started immediate post operatively. Drain was removed at day 2 and suture removal was done on post-operative day 12. Mobilization was allowed with lumbosacral brace as tolerated. Scoring of outcome was done at 6 week, 3 months and 6 months. Back pain and work status was assessed by Denis et al pain scale and work scale, and radiological improvement was assessed by Meyerding grading system immediately after the surgery, at 6 weeks, 3 months, and 6 months. Serial radiographs of patient no.7 are shown in Figure 2.

Meyerding Grading System calculates slip grade by determining the ratio between the anteroposterior diameter of the top of the cephalad vertebra and the distance the caudad vertebra has slipped anteriorly.
Grade 1: displacement of 25% or less.
Grade 2: displacement between 25% and 50%.
Grade 3: displacement between 50% and 75%.

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Grade 4: displacement of more than 75% Statistical analysis was done using appropriate methods using SPSS version 21.0.

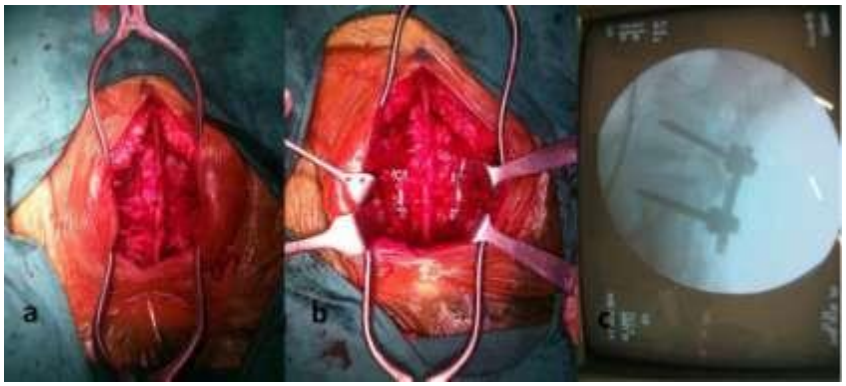

Fig-1: a) Intraoperative photograph showing adequate exposure. b) Shows the four requisite pedicle screws inserted and rods distracted. c) Shows C-arm picture after instrumentation.

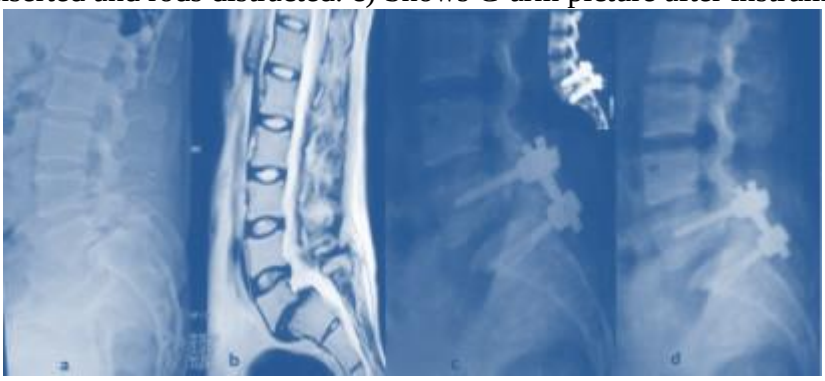

Fig-2: a) Preoperative lateral view showing Grade 2 Spondylolisthesis at L5-S1 level. b) Preoperative MRI in sagittal section. c) X Ray at 6 weeks follow-up; Inset shows immediate post op CT. d) X ray lateral view at 6 months follow-up.

RESULTS

This study were 5 women and 12 men with an average age of 44.35 years. 12 patients had Spondylolisthesis of L5-S1 and 5 patients had Spondylolisthesis at L4-L5. 5 patients (29.4%) had a grade 1 slip, 10 patients (58.82%) had a grade 2 slip, while 2 patients (11.76%) had a grade 3 slip. The average forward translation of the involved vertebral body on the caudal vertebral body was significantly reduced from preoperative measure on the first postoperative ($p<0.005$) and the final follow-up radiograph ($p<0.005$). The translation was 29.55+/-16.58% preoperatively, 9.95+/-7.13% at immediate postoperative period, 9.65+/-7.02% on postoperative follow up at 6 weeks, 9.95+/-7.14% at 3 months follow up and 9.90+/-7.12% at 6 months follow up (Table-1). The postoperative and follow-up measures of forward translation were not significantly different. Thus the reduction gained during surgery was not lost on a follow up of 6 months. The mean Denis et al pain scale (Min 1 to Max 5) reduced from 3.95 preoperatively to 2.25 at 6 weeks and 1.95 at 6 months (Table-2).

Table 1: Percentage of slip preoperatively and postoperatively. There is a statistically significant reduction in slip which at 6 months postop does not recur.

PAIN SCORE	Mean± StdDev	Median	Min-Max	P value
Pre-op	3.95 ± 0.6	4	3-5	-
Post-op Day-1	3.95 ± 0.6	4	3-5	1
6 Weeks	2.25 ± 0.55	2	1-3	<.0005
3 Months	2 ± 0.56	2	1-3	<.0005
6 Months	1.95 ± 0.51	2	1-3	<.0005

Table 2: Denis et al pain score preoperatively, at postop day 1, 6 weeks, 3 months and 6 months post op. There is statistically significant reduction in pain 6 weeks onwards.

Percentage of Slip	Mean ± Std Dev	Median	Min-Max	P value
Pre-Operative	29.55 ± 16.58	30	7-65	-
Post-Operative Day 1	9.95 ± 7.13	10	0-26	1
6 Weeks	9.65 ± 7.02	10	0-26	<.0005
3 Months	9.95 ± 7.14	11	1-26	<.0005
6 Months	9.9 ± 7.12	11	1-26	<.0005

Table 3: Denis et al work score.

Work Score	Mean ±Std Dev	Median	Min-Max	P value
Pre-Operative	3.35 ± 0.67	3	2-5	-
Post-Operative Day 1	3.35 ± 0.67	3	2-5	1
6 Weeks	2.6 ± 0.94	2.5	1-4	<.0005
3 Months	2 ± 0.79	2	1-4	<.0005
6 Months	1.95 ± 0.83	2	1-4	<.0005

The mean work score (Min 1 to Max 5) of 3.95 in preoperative period improved to 2.6 at 6 weeks, 2.0 at 3 months and 1.95 at 6 months follow up (Table 3). Improvement in both pain and work scale were found to be statistically significant ($p<0.0005$). Though Meyer ding grading, Denis Pain and Work Scale all show significant improvement at 6 months, correlation between clinical outcome (pain and work scales), and reduction in grade of slip was not found to be significant ($p>0.05$). Reduction in pain score was found to be significantly correlated ($p<0.05$) with improvement in work score, meaning that decrease in pain led to improvement in work status of the patient. It was observed that reduction in grade of slip was not related to improvement in pain or work score of the patient. Out of 20 patients in our study, 1 patient developed superficial wound infection which was managed successfully with antibiotic coverage after performing culture and sensitivity of wound discharge. There was no implant failure or neurological deterioration post operatively.

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DISCUSSION

Spondylolisthesis literally means slipping of one vertebra over the other. This most commonly occurs due to defect in pars interarticularis, but can also take place due to defect in bony hook that includes the pedicle, inferior facets of cranial vertebra, and superior facets of caudal vertebra. This causes increased stress on the mechanical stability of spine which allows forward slippage at the involved vertebral level. The Denis et al work score[16] grades the ability to work from 1 i.e. return to previous employment or physically demanding activities to 5 i.e. no work and patient being completely disabled. The treatment modalities for spondylolisthesis essentially include a mandatory conservative therapy trial, which includes restricted activity, spinal flexion exercises, NSAIDs, bracing and physiotherapy. Sunakietal[17]found that patients treated with flexion exercise regime were less likely to require job modification or limit their activities because of pain. They advised surgical intervention in patients in who exercise regime failed to provide relief. Our study included patients only after they failed to get relief from trial of conservative therapy and were willing for surgicalintervention. Moller etal[18] in their prospective randomised study in 111 patients of adult isthmic spondylolisthesis concluded that, surgical management improves function and relieves pain more efficiently than an exercise regime. A number of published studies have shown that surgical management is supported in patients of spondylolisthesis and who did not get relief from conservative treatment[18,19,20]. The mean age of patients in our study was 44.35 years. Males were found to be more affected than females with a ratio of 1.86:1. In a prospective cohort study conducted by Denard PJ etal[21] involving 300 patients, it was found that prevalence of spondylolisthesis increased with age and overall was higher among older men than women. Our study is consistent with these results. Also, spondylolisthesis is found to be more in weight lifters, gymnast and sportspersons. In our study, 40% patients had defect at L4-L5 level, while 60% patients had lesion at L5-S1 level. In a study conducted by Roche et al[22], there was greater involvement at L5-S1 level (82.1%) than L4-L5 level (11.3%). Higher levels were rarely involved. Our findings correlate to this study. Naderiet al[23] had found that in cases of lumbosacral spondylolisthesis, short segment posterior stabilisation does not require surgical reduction and can attain measurable reduction by distacton. In our study, the average slip in pre-operatively was 29.55%. This improved to average 9.95% ($p<0.005$) in immediate post op period, 9.65 in follow up at 6 weeks, 9.95 in follow up at 3 months and 9.90 in follow up at 6 months. This was found to be statistically significant at $p<0.005$. Liu ZD et al[24] found that using polyaxial screw and rod fixation system was simple and showed satisfactory radiographic characteristics and favourable clinical result. Our study also has similar findings. Jiang WY et al[25] in their study concluded that surgical reduction in lumbar spondylolisthesis can improve spinopelvic balance and lead to satisfactory outcome. They found that clinical outcomes were better than proportion of slip reduction; less reduction demonstrated worse clinical outcomes. In our study, preoperative average pain score was found to be 3.95, which improved to 2.25($p<0.0005$) at 6 weeks follow up, and final average score was 1.95 ($p<0.0005$) at 6 months post op. This decrease in pain score when compared in preoperative period to subsequent follow ups was found to be statistically significant. There was no statistical significance between reduction of slip percentage and reduced pain score ($p>0.05$). In the study conducted by Hagenmaieret al[26] it was concluded that clinical outcome was

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not related to obtained radiographic reduction of the slipped vertebra in patients with a lumbar fusion for low grade spondylolisthesis. In our study also reflected this finding. Average work score, as calculated using Denis et al work scale in our study was found to be 3.35 pre operatively. This improved to 2.6 at 6 week follow up ($p<0.05$), score of 2 at 3 month follow up ($p<0.0005$) and finally 1.95 at end of 6 months ($p<0.0005$). This is statistically significant. The study conducted by Lian XF et al[27] found that clinical outcomes are independent of slip grade. Overall, the improvement in work status after surgery, when compared between preoperative period and regular follow ups was found to be significant ($p<0.0005$). Pain score and work score improved over each follow up. It was found that reduction in pain score was significantly related with improvement in pain ($p<0.05$). Oberlinner C et al[28] had shown back pain and stress perception are correlated with each other and both are negatively associated with work ablity. Moreover, Mesas AE et al[29] in a study on the Spanish population showed that workers with chronic back pain were more likely to be absent from work for longer. Our study correlates with these studies. The results of our series clearly demonstrate the ability of this technique to correct slippage in spondylolisthesis, evident by the statistically significant ($P<0.005$) reduction of percentage of slip. Out of those operated, all patients had improvement in clinical outcome which was significant as compared to their status before operative intervention ($p<0.005$). The overall improvement in pain and work scale was better at subsequent follow up. Statistical analysis shows that as the pain improved, the work score of the patient also improved and this correlation was found to be statistically significant ($p<0.05$). Clinical outcomes did not significantly correlate with correction in grade of slip (as determined by Meyerding grading), though this might be due to the small study numbers. This suggests that the amount of reduction or correction in lordosis does not have much effect on the relief of symptoms.

CONCLUSION

In concluded, this study showed that short segment fixation in spondylolisthesis using pedicle screws and interlaminar fusion with autologous bone grafting leads to improved clinical and radiological outcome in patients who have failed to get relieved by conservative therapy. The procedure leads to relief of pain and ability to resume previous work. However, reduction in grade of slippage was not found to be related to improvement in pain and work status of the patient. Longer follow up is needed for radiological assessment of interlaminar fusion.

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