

Original Article

A Comparative Study of Lever Reduction (RF) in Different Grades of Lumbosacral Degenerative Spondylolisthesis

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Abstract: Spondylolisthesis has many etiologies, all of which ultimately lead to a loss of the stability offered by the locking mechanism of the articular processes of the vertebrae that allow the superior vertebrae to slide forward over the inferior vertebrae. This study compared the Lever Reduction (RF) in different grades of Lumbosacral Degenerative Spondylolisthesis. Cross sectional retrospective hospital based descriptive study was done in the spine surgery of orthopedic department in Tai he hospital was enrolled in this study. Data was analyzed using Microsoft excel 2010 spread sheet, and statistical analysis SAS 9.2 software. ODI scoring was done to find out the appropriate comparison in symptomatic outcome before and after surgery in different grades of LSDS. Total 50 cases of Degenerative Spondylolisthesis were taken in whom RF instrument fixation was done in 30 patients, out of it 11(Grade I), 16(Grade II), 3(Grade III), 0(Grade IV) and 0(Grade V). In case of 20 ROD fixations, 6(Grade I), 13(Grade II) and 1(Grade III) were classified before surgery. The average follow-up period more than (6±2 months) and (5±2 months) was available for patients undergone RF and ROD fixation respectively. The average age at the time of surgery was 48.40±3 (45,52) years and 53.53±4 (48,57) years for RF and ROD respectively. The mean operating time was 122±16.11min and 119±17.11min and the mean blood loss during the surgery was 320±43ml and 316±38ml for RF and ROD fixation respectively. The average % slippage, the mean slip angle, SS and ODI score for the patients undergone RF were, 27.52±9.96%, 11.50±4.40°, 40.33±6.43° and 18±7 score before surgery, 15.24±4.55%, 8.60±3.97°, 38.05±6.45° and 8±3 score after surgery respectively, at the last follow-up. The symptomatic degenerative spondylolisthesis continues to be source of low back pain. Reduction Lever fixation system is one of the most common procedures with satisfactory outcomes in contest of improved in clinical and radiographic severity and economically appropriate. However, research on the efficacy is lacking. So, the further study is needed regarding the short- and long-term outcome of RF instrumentations system.

Keywords: spondylolisthesis, RF, degenerative, lumbosacral

1. INTRODUCTION

Spondylolisthesis has many etiologies, all of which ultimately lead to a loss of the stability offered by the locking mechanism of the articular processes of the vertebrae that allow the superior vertebrae to slide forward over the inferior vertebrae [1,3]. The popular classifications describe the various diseases responsible for the slippage; *Newman (1963)* divided the types of Spondylolistheses into five distinct groups, with each subtype emphasizing the lesion in the posterior elements responsible for the slip. The nomenclature for the classification was clarified by *Wiltse et al*, and this remains the most popular classification system to date. They classified Spondylolisthesis as being congenital, isthmic, degenerative, traumatic, and pathologic. Newman later added the classification of iatrogenic Spondylolisthesis. While this classification system principally describes the etiology of the

Spondylolisthesis, it highlights the anatomic lesions responsible for the slip [1,3]. Two classifications commonly are used for Spondylolisthesis: *The Wiltse classification* and *The Marchetti-Bartolozzi classification*. The Wiltse classification is divided into five classes: (1) dysplastic/congenital, (2) isthmic, (3) degenerative, (4) traumatic and (5) pathologic. The Marchetti-Bartolozzi classification is divided into developmental and acquired. Developmental implies there are congenital predispositions. The developmental category contains high and low dysplastic. A highly dysplastic Spondylolisthesis with lysis is most likely to represent a high-grade Spondylolisthesis [2]. Acquired traumatic stress fracture is the common type of low-grade isthmic/lytic Spondylolisthesis seen in teenagers and athletes. Degenerative Spondylolisthesis is most commonly the acquired degenerative primary Spondylolisthesis. The advantages of the Marchetti-Bartolozzi classification are that it takes into account the amount of dysplasia at L5-S1 (i.e. the underdevelopment of the arch of L5), whether the posterior column defect is an acute fracture versus a stress fracture and whether patient has had prior surgery [1,2,3]. Joints of each vertebra are composed of inferior and superior articular processes. Termed as facet joints and articulates between adjacent vertebrae. Fibrous capsules are the main anatomical structure which holds the Facet joints. Process of degeneration leads the facet capsules become thin and weakened. This results in a stretching of the capsule and a sliding of one vertebra on another. This sliding of one vertebra on another is called Spondylolisthesis. As a result of this sliding, there is instability in the joint and the body responds via a thickening (hypertrophy) of the facets. Many patients do not realize that they have degenerative Spondylolisthesis until it is seen on radiographic imaging. Sometimes this forward slippage can cause back pain but often it does not. Unfortunately, some patients do have pain that can result in a significant deterioration in their quality of life. Senile groups of peoples are vulnerable to developed predominantly degeneration of disc and interconnected joints and finally tend to result in Spondylolisthesis and neurological impairment [4,5]. There is numerous risk factors for degenerative Spondylolisthesis are high BMI, sex, age; work related to improper posture as well as generalized OA, spine trauma and anatomical alignment of the spine. Degenerative Spondylolisthesis are often associated with facet joint OA. Low back pain and mechanical symptoms (low back stiffness,) and acute neurological deficit are the most common symptoms among patients with degenerative Spondylolisthesis. Persistent low back pain, intermittent claudication and neurological deficit symptoms currently quite universally considered as absolute indication for surgical treatment [4,5,6,7] So, the presence study was performed to search quick, simple, outcome of the use of RF instrumentation in different grading of Spondylolisthesis. However, the rationale for the current treatment strategy is not supported by high quality evidence. And finally, research on the efficacy is lacking. So, the further study is needed regarding the short- and long-term outcome of RF instrumentation system. Roughly the prevalence of lumbar spondylolysis differs in the literature but has been estimated to be approximately 68% in the general population by some authors, and as high as 63% in those engaging in specific sporting activities, while the reported incidence of spondylolisthesis is suggested to comprise between 2% and 6% of LBP populations. The degenerative form is the most prevalent with isthmic spondylolisthesis more common in individuals aged less than 50 years. Estimates of spondylolisthesis among females range from 6% in Taiwan to 20–25% in the United States, whereas those among males range from 3% in Taiwan and 4–8% in the United States [8]. Despite its common occurrence, few physical findings specific for the detection of LS have been reported [9]. Similarly, from the different literature and articles the prevalence of Spondylolisthesis ranges from as high as 25% in Inuit Eskimo populations to as low as 2-3% in African Americans, with the prevalence amongst Caucasians beings 6% Genetics, family history and race have been implicated in contributing to the development of lumbar Spondylolisthesis [10]. The duration of the pain history is often several years. Even the time between the beginning of the pain and the first complaint to a physician is quite long because of the back pain is often regarded as “trivial suffering” by patients and their relatives. Usually, the discomforts of patients are initially misjudged, and the symptoms are mistaken for growing pains, the initials back pains are

typically slight, generally not very disabling and often exhibits an intermittent character, with long symptom-free intervals. Occasionally, the onset of pain is related to a relatively severe trauma. The fact, however, rarely represents an etiological aspect but is rather an event that the patient remembers well [10,11,12]. DS is a disease of aging. Although more commonly found in women (2–3:1, female: male), its incidence increases in both sexes with age. Its predilection for women is thought to be due to an increase in ligamentous laxity and hormonal effects. There is also evidence to support that baseline lumbar and pelvic parameters may lead to the development of DS [13]. Aono and colleagues followed 142 women without baseline deformity over a mean of 14 years and found an incidence of newly developed DS of 12.7%. The authors reported that increased pelvic incidence, L4 vertebral inclination, an adjusted vertebral size, and facet orientation in the Sagittal plane were all independent predictors of the development of DS. The development of DS is likely a multifactorial process taken together with the above causes as well as degenerative processes of aging affecting both the intervertebral disk and facet joints [13,14]. There is little known about the natural history of DS. Matsunaga and colleagues reported 145 nonsurgical managed patients with a minimum of 10 years' follow-up evaluation. The authors reported slip progression in 49 patients (34%). Intervertebral disk heights of the diseased segment decreased significantly throughout the length of the study with a concomitant decrease in low back pain. They also concluded that this narrowing of the intervertebral disk as well as spur formation, sub cartilaginous sclerosis, or ossification of ligaments may prevent the progression of the disease in a process they call spinal restabilization. More than three quarters of their patient population failed to develop any neurological sequelae after >10 years of follow-up. However, the authors report that the patients who presented with neurological symptoms, but refused surgical treatment, portended the worst prognosis at the final follow-up [15,16,17]. The present study evaluated the usefulness and outcome of RF instrumentation fixation and inter comparison between different grades of degenerative Spondylolisthesis as well as the ultimate outcome evaluation with the ROD fixation.

2. MATERIALS & METHOD

Retrospective hospital based descriptive study was done in Tai He Hospital-Affiliated Hospital to the Hubei University of Medicine, Shiyan, Hubei, P.R. China. This study included the cases of different grades of Degenerative Lumbar Spondylolisthesis who were admitted in the department of Spine Surgery (Orthopedics) of Tai He Hospital. The sample sizes were at least 50 patients of Degenerative Lumbar Spondylolisthesis. Duration of study was 2 years and detailed history was taken; clinical examination and diagnostic radiological imaging was performed. Imaging: L-S X-ray was taken initially, computed tomography planned for more accuracy and MRI was done as a gold standard to rule out neurological involvements. Laboratory investigations: RBC, Total leukocyte count, Differential count of Neutrophils and lymphocytes, Glucose and protein level, Coagulation profile, Viral markers, RFTs/LFTs. The clinical assessment of the patients with Degenerative Spondylolisthesis undergone RF and ROD instrumentation fixations were evaluated up to the F/U period. The duration of the follow up period varies from a six month to 1 year of period. During this time of follow up certain evaluating index; clinical evaluations, radiological findings and the presence of complications were used to assess. As this study work included total (50) cases of Lumbar Degenerative Spondylolisthesis, so the aim was to evaluate the usefulness of RF instrumentation and fixation surgery with the evaluation of outcome and improvement in clinical status before and after surgery in term of using descriptive statistical parameters. The selection of the patients after the clinical and radiological imaging evaluation, proper recording of the patients was done along with the relevant identification. Data was analyzed using Microsoft excel 2010 spread sheet, statistical analysis SAS V9.2 software. The analysis of statistical difference in dependent variables was carried out with the student's t-test for paired data. The tests employed for the study of the statistical association between two independent variables were the χ^2 test and the Pearson's correlation coefficient for the quantitative variables. Quantitative and

Qualitative data were presented by bar diagram and pie chart. The confidence level of the study was kept at 95%, hence a "p" value less than 0.05 indicated as a significant association.

3. RESULTS & DISCUSSION

Based on the clinical symptoms and radio graphic imaging used in diagnosing, this study total of 50 cases of Lumbo-sacral degenerative spondylolisthesis has been taken in whom 30 cases were undergone RF instrumentation and 15 were undergone ROD fixation. Different parameters were taken for the evaluation of surgery.

Table 01: Slip % for RF

Variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre slip	30	0.2752	0.0996	0.0192	14.35	<.0001
Post slip	30	0.1524	0.0455	0.0088	17.41	<.0001
d	30	0.1227	0.0875	0.0168	7.29	<.0001

$p(>|t(v=29)=0.0001|)<0.05\alpha$ So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post slip % in a patients undergone RF. The CI lies between 0.238(23.8%) and 0.3122(31.22%) pre-operatively and 0.1370(13.70%) and 0.1683(16.83%) post-operatively respectively.

Table 02: Slip angle for RF

Variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre slip angle	30	11.5089	4.4046	0.8477	13.58	<.0001
Post slip angle	30	8.6074	3.9783	0.7656	11.24	<.0001
d	30	2.9015	3.4638	0.6666	4.35	0.0002

$P(>|t(v=29)=0.0002|)<0.05\alpha$ So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post slip angle in a patients undergone RF. The CI lies between 9.84° and 13.17° pre-operatively and 7.10° and 10.10° post-operatively respectively.

Table 03: Sacral slop/SS for RF

Variable	N	Mean	Std Dev	Std Error	t Value	Pr> t
Pre SS	30	40.3330	6.4300	1.2375	32.59	<.0001
Post SS	30	38.0574	6.4523	1.2417	30.65	<.0001
d	30	2.2756	4.7318	0.9106	2.50	0.0191

$P(>|t(v=29)=0.0191|)<0.05\alpha$, so we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post SS in a patients undergone RF.

Table 04: ODI for RF

Variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre ODI	30	18.4000	7.1129	1.2986	14.17	<.0001
Post ODI	30	8.0333	3.7091	0.6772	11.86	<.0001
d	30	10.3667	7.1365	1.3029	7.96	<.0001

$P(>|t(v=29)=0.0001|) < 0.05\alpha$, so we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post ODI in a patients undergone RF.

Table 05: Slip% for ROD

Variable	N	Mean	Std Dev	Std Error	t Value	Pr> t
Pre slip	20	0.2477	0.0871	0.0242	10.25	<.0001
Post slip	20	0.1742	0.0617	0.0171	10.18	<.0001
d	20	0.0735	0.0602	0.0167	4.41	0.0009

$P(>|t(v=12)=0.0009|) < 0.05\alpha$, so we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post slip percentage in a patients undergone ROD instrumentation.

Table 06: Slip angle for ROD

Variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre slip angle	20	11.4892	3.7163	1.0307	11.15	<.0001
Post slip angle	20	9.4308	5.1083	1.4168	6.66	<.0001
d	20	2.0585	3.1104	0.8627	2.39	0.0344

$P(>|t(v=12)=0.0344|) < 0.05\alpha$, so we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post slip angle in a patients undergone ROD instrumentation.

Table 07: Sacral slop/SS for ROD

Variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre SS	20	33.8723	8.2322	2.2832	14.84	<.0001
Post SS	20	31.2662	4.5122	1.2515	24.98	<.0001
d	20	2.6062	5.7156	1.5852	1.64	0.1261

$P(>|t(v=12)=0.126|) > 0.05\alpha$, so we cannot reject H_0 (null hypothesis): $d=0$ and there is no significant difference between pre and post SS in a patients undergone ROD instrumentation.

Table 08: ODI for ROD

Variable	N	Mean	Std Dev	Std Error	t Value	Pr> t
Pré ODI	20	16.6000	6.0123	1.3444	12.35	<.0001
Post ODI	20	11.6000	4.1852	0.9358	12.40	<.0001
d	20	5.0000	4.9524	1.1074	4.52	0.0002

$P(>|t(v=29)=0.0002|) < 0.05\alpha$. So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post ODI in a patient's undergone ROD.

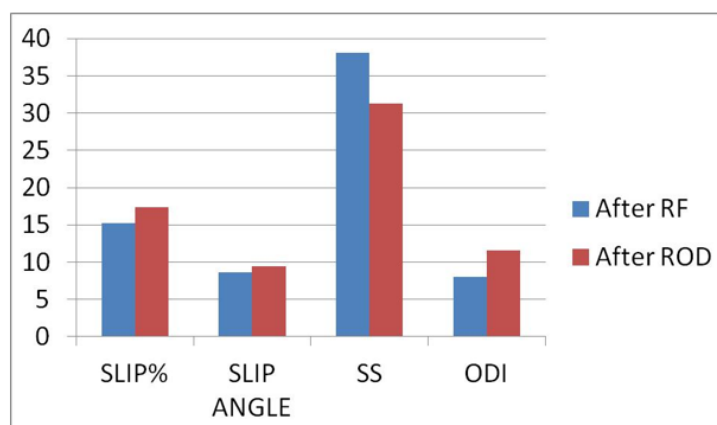


Figure 01: Bar diagram showing difference After RF and After ROD

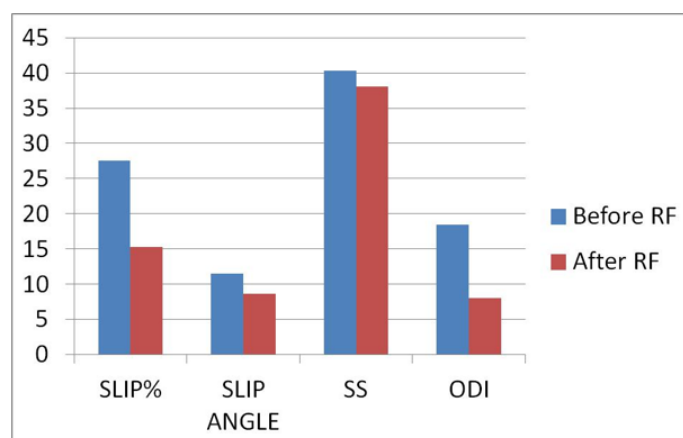


Figure 02: Bar diagram showing difference Before RF and After RF

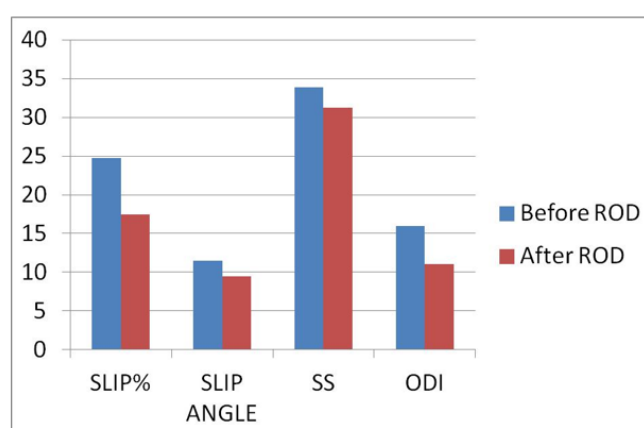


Figure 03: Bar diagram showing difference Before ROD and After the ROD

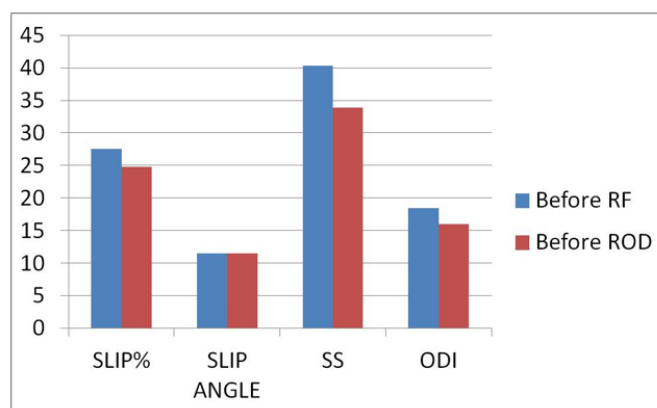


Figure 04: Bar diagram showing difference Before RF and Before ROD

Table 09: Slip% for grade I after RF

Variable	N	Mean	Std Dev	Std Error	t Value	Pr> t
Pre slip%	11	0.1790	0.0343	0.0103	17.31	<.0001
Post slip%	11	0.1227	0.0250	0.0075	16.29	<.0001
d	11	0.0563	0.0323	0.0097	5.78	0.0002

$p(>|t(v=10)=0.0002|)<0.05\alpha$. So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post slip % in a patient with grade I spondylolisthesis who had undergone RF instrumentation. The CI lies between 0.159(15.9%) and 0.198(19.8%) pre-operatively and 0.108(10.8%) and 0.135(13.5%) post-operatively respectively.

Table 10: slip% for grade II after RF

Variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre slip%	16	0.3059	0.0402	0.0101	30.40	<.0001
Post slip%	16	0.1710	0.0460	0.0115	14.87	<.0001
d	16	0.1349	0.0618	0.0155	8.73	<.0001

$P(>|t(v=15)=0.0001|)<0.05\alpha$. So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post slip % in a patient with grade II spondylolisthesis who had undergone RF instrumentation. The CI lies between 0.286(28.6%) and 0.325(32.5%) pre-operatively and 0.149(14.9%) and 0.192(19.2%) post-operatively respectively.

Table11: slip% in grade III after RF

Variable	N	Mean	Std Dev	Std Error	t Value	Pr> t
Pre slip%	3	0.5133	0.0143	0.0083	62.20	0.0003
Post slip%	3	0.2080	0.0751	0.0434	4.79	0.0409
d	3	0.3053	0.0892	0.0515	5.93	0.0273

$P(>|t(v=2)=0.0273|)<0.05\alpha$. So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post slip % in a patient with grade III spondylolisthesis who had

undergone RF instrumentation. The CI lies between 0.496(49.6%) and 0.529(52.9%) pre-operatively and 0.122(12.2%) and 0.293(29.3%) post-operatively respectively.

Table12: slip angle in grade I after RF

Variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre slip angle	11	9.3045	4.9792	1.5013	6.20	0.0001
Post slip angle	11	7.2800	4.1459	1.2500	5.82	0.0002
d	11	2.0245	2.9532	0.8904	2.27	0.0460

$P(>|t(v=10)=0.0463|) < 0.05\alpha$. So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post slip angle in a patient with grade I spondylolisthesis who had undergone RF instrumentation. The CI lies between 6.362° and 12.24° pre-operatively and 4.84° and 9.74° post-operatively respectively.

Table13: slip angle in grade II after RF

Variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre slip angle	16	13.1031	2.8345	0.7086	18.49	<.0001
Post slip angle	16	9.0838	2.4236	0.6059	14.99	<.0001
d	16	4.0194	2.9055	0.7264	5.53	<.0001

$P(>|t(v=15)=0.0001|) < 0.05\alpha$. So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post slip angle in a patient with grade II spondylolisthesis who had undergone RF instrumentation. The CI lies between 11.71° and 14.49° pre-operatively and 7.89° and 10.27° post-operatively respectively.

Table14: slip angle in grade III after RF

Variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre slip angle	3	7.5933	2.5284	1.4598	5.20	0.0350
Post slip angle	3	5.4733	2.5324	1.4621	3.74	0.0645
d	3	2.1200	0.7119	0.4110	5.16	0.0356

$P(>|t(v=2)=0.0366|) < 0.05\alpha$. So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post slip angle in a patient with grade III spondylolisthesis who had undergone RF instrumentation. The CI lies between 4.73° and 10.45° pre-operatively and 2.60° and 8.33° post-operatively respectively.

Table15: sacral slop/SS in grade I after RF

variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre SS	11	37.7118	5.7864	1.7447	21.62	<.0001
Post SS	11	34.8755	6.4812	1.9542	17.85	<.0001
d	11	2.8364	2.1517	0.6488	4.37	0.0014

$P(>|t(v=10)=0.0014|) < 0.05\alpha$. So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post SS in a patient with grade I spondylolisthesis who had undergone RF instrumentation. The CI lies between 34.29° and 41.12° pre-operatively and 31.05° and 38.69° post-operatively respectively.

Table16: sacral slop/SS in grade II after RF

Variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre SS	16	42.9100	5.8938	1.4734	29.12	<.0001
Post SS	16	38.4575	6.5955	1.6489	23.32	<.0001
d	16	4.4525	3.9973	0.9993	4.46	0.0005

$P(>|t(v=15)=0.0005|)<0.05\alpha$. So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post SS in a patient with grade II spondylolisthesis who had undergone RF instrumentation. The CI lies between 40.02° and 45.79° pre-operatively and 35.22° and 41.68° post-operatively respectively.

Table17: sacral slop/SS in grade III after RF

Variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre SS	3	44.0067	2.5068	1.4473	30.41	0.0011
Post SS	3	38.9167	4.6106	2.6619	14.62	0.0046
d	3	5.0900	2.7566	1.5916	3.20	0.0854

$P(>|t(v=2)=0.0854|)>0.05\alpha$. So, we cannot reject H_0 (null hypothesis): $d=0$ and there is no significant difference between pre and post SS in a patient with grade III spondylolisthesis who had undergone RF instrumentation. The CI lies between 41.17° and 46.84° pre-operatively and 33.70° and 44.13° post-operatively respectively.

Table18: ODI in grade I after RF

Variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre ODI	11	18.6364	8.4885	2.5594	7.28	<.0001
Post ODI	11	7.5455	3.2974	0.9942	7.59	<.0001
d	11	11.0909	6.5185	1.9654	5.64	0.0002

$P(>|t(v=15)=0.0002|)<0.05\alpha$. So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post ODI score in a patient with grade I spondylolisthesis who had undergone RF instrumentation. The CI score lies between 13.63 and 23.62 pre-operatively and 5.59 and 9.48 post-operatively respectively.

Table19: ODI in grade II after RF

Variable	N	Mean	Std dev	Std error	T value	Pr> t
Pre ODI	16	17.5625	4.0492	1.0123	17.35	<.0001
Post ODI	16	8.5625	3.5957	0.8989	9.53	<.0001
d	16	9.0000	4.9126	1.2281	7.33	<.0001

$P(>|t(v=15)=0.0001|)<0.05\alpha$. So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post ODI score in a patient with grade II spondylolisthesis who had undergone RF instrumentation. The CI score lies between 15.57 and 19.54 pre-operatively and 6.79 and 10.30 post-operatively respectively.

Table20: ODI in grade III after RF

Variable	N	Mean	Std Dev	Std Error	t Value	Pr> t
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Pre ODI	3	17.6667	4.5092	2.6034	6.79	0.0210
Post ODI	3	9.6667	5.6862	3.2830	2.94	0.0986
d	3	8.0000	2.0000	1.1547	6.93	0.0202

$P(>|t(v=15)=0.0202|) < 0.05\alpha$. So, we can reject H_0 (null hypothesis): $d=0$ and there is a significant difference between pre and post ODI score in a patient with grade III spondylolisthesis who had undergone RF instrumentation. The CI score lies between 12.56 and 22.75 pre-operatively and 3.23 and 16.08 post-operatively respectively.

Table21: Pearson's Linear Regression Different grades and ODI score in RF

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr> t
Intercept	1	6.50963	0.26324	24.73	0.0257
GRADE	1	0.06242	0.00731	8.54	0.0742

Cannot reject H_0 at $\alpha=0.05$ ($p=0.07>0.05$) two-sided, Different grading obtained pre-operatively has no significant positive effect on ODI score obtained post-operatively. Every increase in Slip %(Grading) can cause no increase in ODI score obtained post-operatively in average.

Table22: Gender and Grades undergone RF

Statistics for Table	DF of Grade	Value by gender	Prob
Chi-Square	2	0.9070	0.6354
Likelihood Ratio Chi-Square	2	0.9066	0.6355
Mantel-Haenszel Chi-Square	1	0.7800	0.3772
Phi Coefficient		0.1739	
Contingency Coefficient		0.1713	
Cramer's V		0.1739	
Sample Size	30		

From the (Table22) Chi-Square distribution ($p>0.05$, cannot reject null hypothesis), showed there was no any obvious relationship between gender and grading of LSDs undergone RF instrumentation.

Table 23: Types of OT and Pre/Post ODI

Statistic	DF	Value	Prob
Chi-Square	1	0.6852	0.4078
Likelihood Ratio Chi-Square	1	0.6881	0.4068
Continuity Adj. Chi-Square	1	0.2977	0.5853
Mantel-Haenszel Chi-Square	1	0.6727	0.4121
Phi Coefficient		0.1120	
Contingency Coefficient		0.1113	
Cramer's V		0.1120	
Sample Size =	54.63		

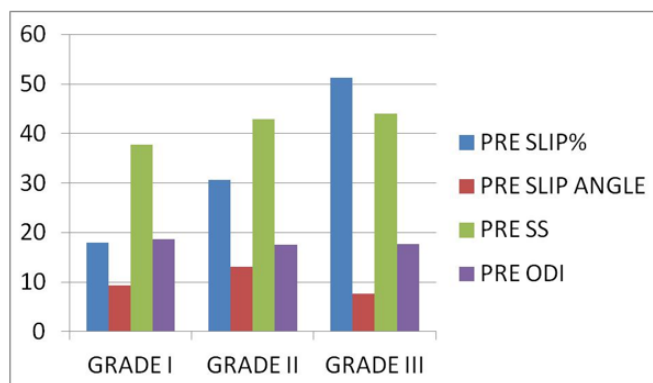


Figure 05: Bar diagram showing difference in pre-operative slip %, slip angle, SS and ODI score in different grades of degenerative spondylolisthesis

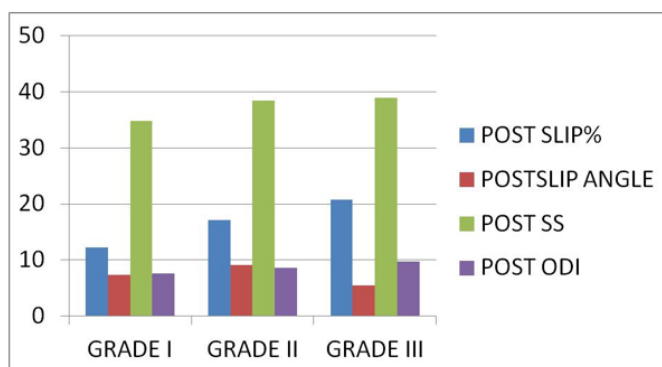


Figure 06: Bar diagram showing difference in pre-and post-operative slip % in different grades of degenerative spondylolisthesis

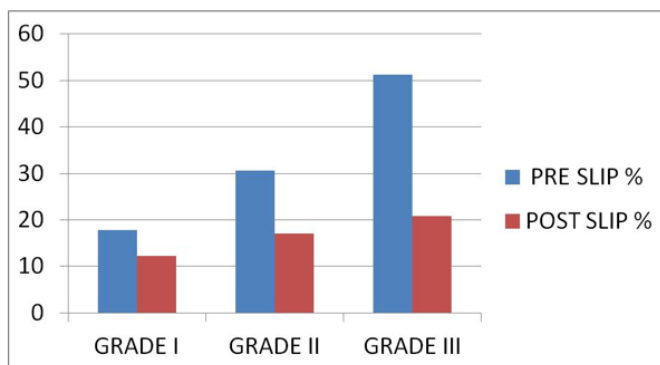


Figure 07: Bar diagram showing difference in pre-and post-operative slip angle in different grades of degenerative spondylolisthesis

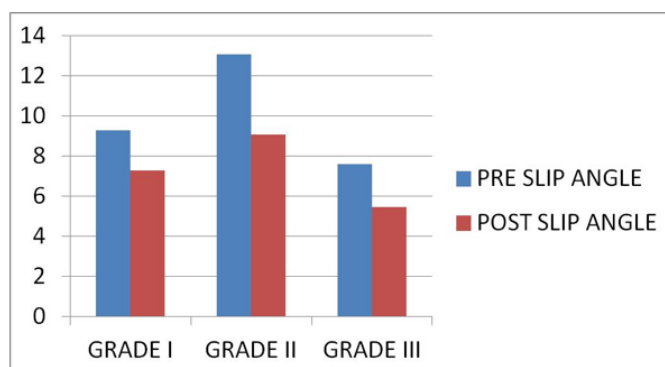


Figure 08: Bar diagram showing difference in pre-and post-operative SS in different grades of degenerative spondylolisthesis

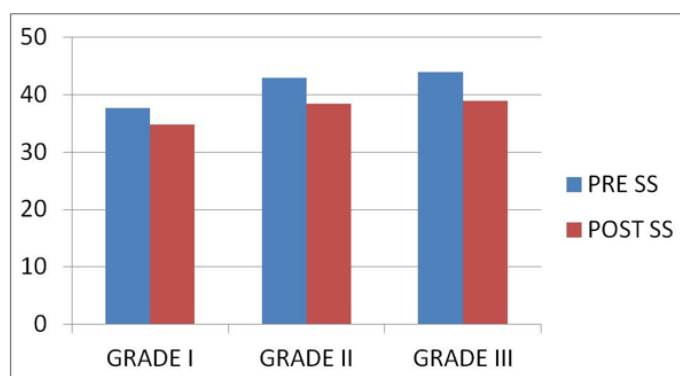


Figure 09: Bar diagram showing difference in pre-and post-operative ODI in different grades of degenerative spondylolisthesis

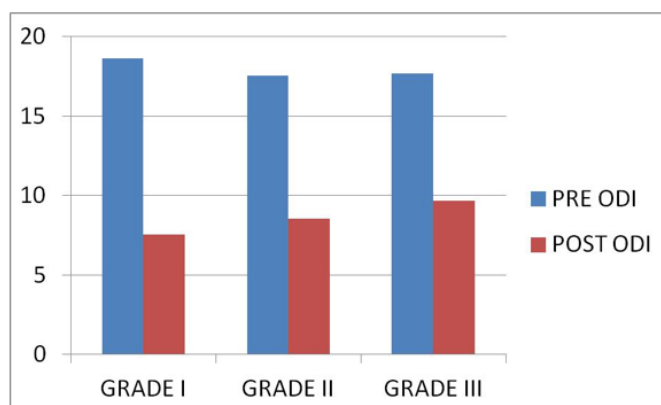


Figure10: Bar diagram showing difference in pre-and post-operative ODI in different grades of degenerative spondylolisthesis

Table24: ODI % calculation for different Grades

PRE-OPERATIVE	POST-OPERATIVE	OPERATION	GRADES
36% (moderate disability)	22% (moderate disability)	ROD	
36% (moderate disability)	16% (minimal disability)	RF	
36% (moderate disability)	14% (minimal disability)	RF	I
34% (moderate disability)	16% (minimal disability)	RF	II
34% (moderate disability)	18% (minimal disability)	RF	III

DISCUSSION

The symptomatic spondylolisthesis in patients aged over 50(or $\geq$) years can be treated surgically with good results and low morbidity. A degenerative spondylolisthesis is often associated with early-stage intervertebral OA, a disorder also involving the facet joints. The spondylolisthesis could be the result of the compromised intervertebral and peri vertebral structure decreased ability to withstand loads and force transmissions during normal movements' joint loads [18,19]. The rationale for performing RF fixation is to alleviate or even cure/treat spine symptoms and eventually related disability by repositioning displaced vertebrae, decompression and fixation to maintain the stability. Reduction of slippage could effectively relieve clinical complaints and reconstitute physiological spinal load bearing and Spino-pelvic balance. Persistent low back pain and intermittent claudication is the most common symptom leading to surgery, but there are also other indications, such as so- called neurological symptoms (weakness, numbness). There is a myriad of studies (uncontrolled case series) suggesting that RF fixation can work in patients with degenerative spondylolisthesis. The outcome of surgery in these observational studies is generally good. Most patients achieve an excellent or good outcome, but despite that, substantial disability, and reduced activity levels is evident 6 months after RF fixation [20,21]. The surgical techniques including translation reduction with double-threaded screws, distract and slip reduction, and insert-and-rotate posterior lumbar Interbody fusion technique have been reported in the literature. Using a posterior-only approach, the above-described technique could yield substantial deformity correction [22]. There is no benefit of conservative treatment for degenerative spondylolisthesis in comparison with operative treatment for middle-aged patients and elderly with clinical and neurological symptoms with or no concomitant osteoarthritis. Unfortunately, as they are uncontrolled, most of these studies are associated with high risk of bias. Further, the distinction between all the types/grades of spondylolisthesis is not always clear, although this is important information as the prognosis for degenerative changes is also satisfactory. For the RF instrumentation from the hypothesis testing, it was found to be there was significant difference between the pre-operative and post-operative slip%($P<0.05$), as well as we are 95% confident that the CI lies between 23.8% and 31.22% in pre- operative cases which was far higher compared with post-operative CI which covered 95% confident level ranged from 13.70% and 16.83% respectively. Grossly we can come to the conclusion that the severity of Slip percentage obtained from the radiological imaging has been improved to some extent after the surgery which directly implies its positive impact in improvement in the clinical condition of patients after the surgery .Similarly, from the hypothesis testing it was found to be there was significant difference between the pre-operative and post-operative slip angle ($P<0.05$), as well as we are 95% confident that the CI lies between 9.847degree and 13.17degree in pre-operative cases which was far more high compared with post-operative CI which covered 95% confident level

ranged from 7.10 degree and 10.10 degree respectively. As well as for the SS from the hypothesis testing it was found to be there was significant difference between the pre-operative and post-operative SS ($P < 0.05$), as well as we are 95% confident that the CI lies between 37.90 degree and 42.75 degree in pre-operative cases which was far more than compared with post-operative CI which covered 95% confident level ranged from 35.62 degree and 40.49 degree respectively. ODI score also found to be there was significant difference between pre- and post-operative ($p < 0.05$). Grossly we can come to the conclusion that the severity of Slip angle and SS obtained from the radiological imaging has been improved (reduced than before) to some extent after the surgery which directly implies its positive impact in improvement in the clinical condition of patients after the surgery. For the ROD fixation from the hypothesis testing, it was found to be there was significant difference between the pre-operative and post-operative slip% ($P < 0.05$), as well as we are 95% confident that the CI lies between 20.2% and 29.51% in pre-operative cases which was far higher compared with post-operative CI which covered 95% confident level ranged from 14.06% and 20.77% respectively. Similarly, from the hypothesis testing it was found to be there was significant difference between the pre-operative and post-operative slip angle ($p < 0.05$), as well as we are 95% confident that the CI lies between 9.46° and 13.50° in pre-operative cases which was far higher compared with post-operative CI which covered 95% confident level ranged from 6.65° and 12.20° respectively. Grossly we can come to the conclusion that the severity of Slip%, Slip angle obtained from the radiological imaging has been improved to some extent after the surgery which directly implies its positive impact in improvement in the clinical condition of patients after the surgery. As well as from the hypothesis testing it was found to be there was no significant difference between the pre-operative and post-operative SS ($p > 0.05$), as well as we are 95% confident that the CI lies between 29.397° and 38.34° in pre-operative cases which was high compared with post-operative CI which covered 95% confident level ranged from 28.81° and 33.71° respectively. Concerned to the ODI pre- and post-operative was different ($p < 0.05$). Grossly we can come to the conclusion that the severity of SS obtained from the radiological imaging has been not improved after the surgery which directly implies that there are no significant changes in SS despite of improved clinical condition of patients after the surgery. Slip% for different grades after RF instrumentation; Grade I [$P(>|t(v=10)| = 0.0002) < 0.05\alpha$] The CI lies between 0.159(15.9%) and 0.198(19.8%) pre-operatively and 0.108(10.8%) and 0.135(13.5%) post-operatively respectively, Grade II [$P(>|t(v=15)| = 0.0001) < 0.05\alpha$] The CI lies between 0.286(28.6%) and 0.325(32.5%) pre-operatively and 0.149(14.9%) and 0.192(19.2%) post-operatively respectively, Grade III [$P(>|t(v=2)| = 0.0273) < 0.05\alpha$] The CI lies between 0.496(49.6%) and 0.529(52.9%) pre-operatively and 0.122(12.2%) and 0.293(29.3%) post-operatively respectively. Similarly Slip angle for different grades after RF instrumentation; Grade I [$P(>|t(v=10)| = 0.0463) < 0.05\alpha$] The CI lies between 6.362° and 12.24° pre-operatively and 4.84° and 9.74° post-operatively respectively, Grade II [$p(>|t(v=15)| = 0.0001) < 0.05\alpha$] The CI lies between 11.71° and 14.49° pre-operatively and 7.89° and 10.27° post-operatively respectively, Grade III [$p(>|t(v=2)| = 0.0366) < 0.05\alpha$] The CI lies between 4.73° and 10.45° pre-operatively and 2.60° and 8.33° post-operatively respectively. As well as for the Sacral slop/SS for different grades after RF instrumentation; Grade I [$p(>|t(v=10)| = 0.0014) < 0.05\alpha$] The CI lies between 34.29° and 41.12° pre-operatively and 31.05° and 38.69° post-operatively respectively, Grade II [$p(>|t(v=15)| = 0.0005) < 0.05\alpha$] The CI lies between 40.02° and 45.79° pre-operatively and 35.22° and 41.68° post-operatively respectively, Grade III [$p(>|t(v=2)| = 0.0854) > 0.05\alpha$] The CI lies between 41.17° and 46.84° pre-operatively and 33.70° and 44.13° post-operatively respectively. On contrary, ODI for different grades after RF instrumentation; Grade I [$p(>|t(v=10)| = 0.0002) < 0.05\alpha$] The CI lies between 13.63 and 23.62 pre-operatively and 5.59 and 9.48 post-operatively respectively, Grade II [$p(>|t(v=15)| = 0.002) < 0.05\alpha$] The CI lies between 15.57 and 19.54 pre-operatively and 6.79 and 10.30 post-operatively respectively, Grade III [$p(>|t(v=2)| = 0.0202) > 0.05\alpha$] The CI lies between 12.56 and 22.75 pre-operatively and 3.23 and 16.08 post-operatively respectively.

4. CONCLUSIONS

The present study highlights the effectiveness of surgical interventions in the management of degenerative spondylolisthesis, a condition that continues to pose clinical challenges. Significant improvements were observed postoperatively in slip percentage, slip angle, sacral slope (SS), and Oswestry Disability Index (ODI) scores ($p < 0.05$), indicating that surgical treatment positively impacts both radiological and clinical outcomes. Comparisons between fixation methods demonstrated that reduction of slip percentage and slip angle, as well as improvement in ODI, were more favorable following RF fixation than ROD instrumentation, suggesting that RF provides superior stabilization and functional recovery. However, SS reduction was less satisfactory with RF compared to ROD fixation. When analyzed across grades of spondylolisthesis, outcomes varied: grade II patients showed the most significant improvement in slip angle reduction, while grade III patients demonstrated greater improvement in slip percentage and SS reduction. Functional outcomes, as reflected by ODI scores, improved across all grades, with grade I patients undergoing RF fixation achieving the most satisfactory improvement, progressing from moderate to minimal disability. Overall, both RF and ROD instrumentation are effective surgical options, but RF fixation appears to offer greater clinical and radiological benefit, particularly in lower grades of spondylolisthesis. These findings emphasize the importance of individualized surgical planning based on disease severity and grade to optimize patient outcomes.

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