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Original Research Paper

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POSTERIOR PEDICLE FIXATION-BASED DYNAMIC STABILIZATION DEVICES FOR THE TREATMENT OF DEGENERATIVE DISEASES OF THE LUMBAR SPINE: INSTITUTIONAL STUDY

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ABSTRACT

Background Fusion and rigid instrumentation is currently the mainstay for the surgical treatment of degenerative diseases of the spine over the last four decades. Rigid spinal implants along with fusion lead to increase in the stress of the adjacent segments and fatigue failure of implants. Although the spinal fusion had been the cornerstone of surgical treatment for back pain during the last three decades 1 in many cases persistent back pain despite a solid fusion continues to haunt the surgeons and patients2. Our institute did the retrospective study with series comparison of both types of stabilisation. This article compares the dynamic stabilization of the lumbar spine with rigid fusion in a series of ten cases at our institute and talks about chronologically some novel dynamics

Methods:

Study design: Retrospective study of comparing dynamic screw fixation with the rigid fixation

Dates searched : Sep 2017- Sep 2018 at Army Hospital (R & R)

Inclusion criteria: Painful degenerative lumbar disc disease with failed conservative management. Patients with grade one mobile spondylolisthesis. Single level dynamic stabilization. Patients with Chronic Low back ache with sciatica and claudication.

Exclusion criteria: Patients less than 18 years and more than 70 years of age. Previous lumbar surgeries.Multi segment involvement. Vertebral fracture or degenerative scoliosis. Patients with trauma, primary infection or inflammatory cause, fracture, Paget disease, osteochondrosis, congenital malformation, or visceral diseases, or previous lumbar surgery were excluded from the surgery

Outcomes: Clinical outcomes (Visual analogue scale (VAS) for low back and lower leg pain; Oswestry disability index (ODI);) and radiological outcomes

Results: Significant post op VAS improvement in both groups. Significant improvement of ODI in the dynamic group. Radiologically the involved discs in both the dynamic and rigid group continued to degenerate with loss of disc height (Rigid > Dynamic).

Conclusions: Patients with posterior dynamic screw stabilisation has better relief of pain and maintenance of sagittal balance as compare to patients with standard rigid fixation. Dynamic screw stabilisation appears to be a good alternative to rigid fixation.

KEYWORDS : Degenerative disc disease, dynamic stabilization, lumbar spine, rigid stabilization.

INTRODUCTION

Dynamic stabilization of the spine was developed for mimicking natural spine movements. Transferring the load from a degenerated disc or facet to a dynamic stabilization construct while preserving segmental motion is a critical feature required to develop dynamic stabilization devices.

Pedicle screw-based posterior dynamic stabilization (PDS) evolved because of failure of fusion to address mechanical back pain due to spinal instability. The current understanding of spinal instability is abnormal quality of motion, leading to uneven load transmission. The primary biomechanical goals of PDS devices are to preserve motion as much as possible and to unload the disc and facet joints by load sharing. Survival against fatigue failure is the biggest challenge for PDS device because of the need for continued motion for an indefinite period. The key to this survival is uniform load sharing throughout the range of motion.

Lumbar degenerative disc disease (LDDD) has become a chronic health problem because of the aging population. Chronic low back pain is the major finding of LDDD in the aging spine. Generally, low back pain may originate from the vertebral endplates, disc annulus, vertebral periosteum, facet joints, and soft tissues. As a conventional surgical treatment, fusion was the first choice for chronic low back pain for many years. However, the clinical outcome of fusion has been shown to be worse than the radiological outcome [2]. Many patients have failed to improve after successful spinal fusion [3]. Additionally, fusion may accelerate degeneration of adjacent segments, making alternative treatments attractive [4].

The primary mechanism of chronic low back pain is theorized to be abnormal load distribution across the disc space following disc degeneration [5]. Lack of relief of low back pain postoperatively may be a result of failure to rectify abnormal load transmission patterns in the disc space [6]. The ideal system should permit controlled motion and increased load sharing without sacrificing construct stability. Especially over the last 10 years, the interest of spine surgeons in dynamic stabilization procedures has increased. Recently, various posterior dynamic stabilization systems have become an alternative to fusion for the treatment of degenerative problems in the lumbar spine. The goal of dynamic stabilization is to unload the disc and facet joints, preserve motion under mechanical load, and restrict abnormal motion in the spinal segment [6].

MATERIALS AND METHODOLOGY

In a span of one year a total of 20 patients who underwent fixation for Grade 1 listhesis were included in the study. Among them 10 patients were stabilised with rigid system and the other 10 patients were stabilised by dynamic screw fixation (figure 1).

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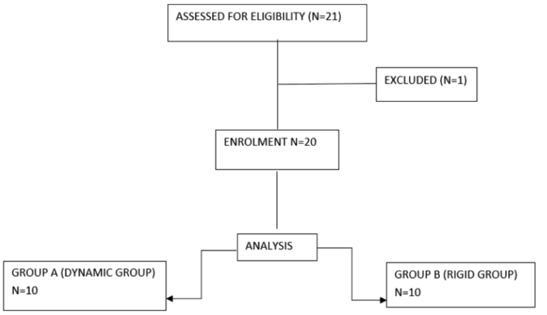


Figure 1

RESULTS

Of these 10 patients in dynamic group, there were 07 men and 03 women, and the mean age was 53.5 years at the time of surgery. The mean clinical follow-up duration was of 06 months along with the radiological follow up. The mean weight of patients was 60 kg .Of the 10 adult patients in the rigid stabilization group, there were 06 men and 04 women, with mean age 52 years. The mean weight of patients was 62 Kg . All of them were symptomatic with Low back ache with sciatica and neurogenic claudication.(Table 1).

Significant improvement of ODI seen with 33 % improvement in ODI in dynamic group and 45 % improvement in rigid group in a follow up period of six months (Fig 2 & Fig 3). Significant post op VAS improvement seen in both the groups with VAS Score Post op in Dynamic group was 5.2 and in rigid group was 6.1.(Table 2 & Fig 4) . Radiologically showed adjacent segment degeneration in both the groups (Rigid > Dynamic) (Fig 5 & Table 3)

Table 1

	Dynamic Group (n=10)	RIGID Group (n=10)
Age (Average)	53.5	52
Male No. (%)	7(70%)	6(60%)
Female No. (%)	3(30%)	4(40%)
All the levels had grade 1 Listhesis		
L3-L4	4	3
L4-L5	4	4
L5-S1	2	3
SYMPTOMS	**DYNAMIC**	**RIGID**
Low Back Ache	3	4
Lowbackache with claudication	4	3
Lowbackache with sciatica	3	3

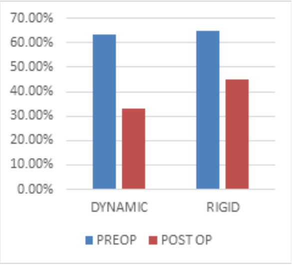


Fig2

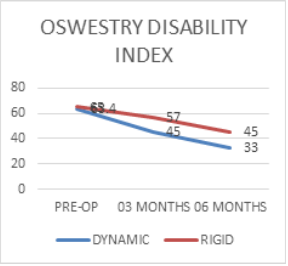


Fig 3

Table 2

CATEGORY	DYNAMIC	RIGID
Age	52 ± 08	53.5 ± 09
Weight (Kg)	60 ± 08	62 ± 09
BMI (kg/m^2)	25±04	24 ± 02
Gender (M/N)	7 / 10	6 / 10
Pre-op/post op VAS score	8.4/5.2	7.5/6.1

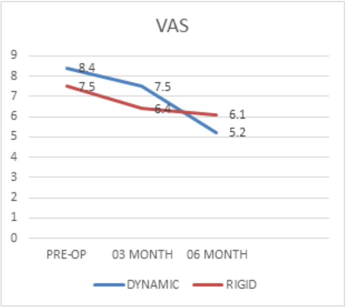
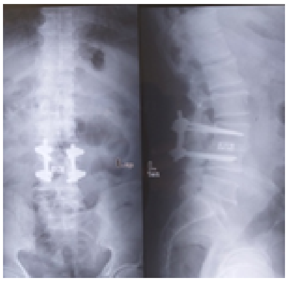


Fig 4

(Fig 5 A) Rigid



(Fig 5 B) Dynamic

Table 3

CATEGORIES	PRE-OP	POST-OP (06 Months)
Involved disc height (mm)		
Dynamic	9.5	8.7
Rigid	10.4	9.2
Upper adjacent disc height (mm)		
Dynamic	10.8	10
Rigid	13	11.8
Lower adjacent disc height (mm)		
Dynamic	8.3	7.5
Rigid	9.5	8.5

All operations were performed under general anesthesia in knee-chest position to maintain lordosis of lumbar vertebrae. The surgical approach was along the median line, opening the lumbar aponeurosis, and rasping the paravertebral muscles through the facet joints. Laminectomy and discectomy were performed according to the indications of each patient before dynamic screw insertion.In the similar way patients underwent rigid fusion with pedicle screw fixation using the same procedure. Both were placed under fluoroscopic visualisation

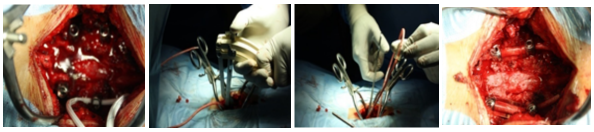


Fig. 6

DISCUSSION

Dynamic stabilization of the spine was developed to solve this problem by mimicking natural spine movements. Transferring the load from a degenerated disc or facet to a dynamic stabilization construct, while preserving segmental motion, is a critical feature required to develop novel dynamic stabilization devices.

Dynamic system evolved from failure of fusion to address mechanical back pain due to spinal instability. The current understanding of spinal instability is abnormal quality of motion, leading to uneven load transmission. The primary biomechanical goals of PDS devices are to preserve motion as much as possible, but to prevent any abnormal motion, and to unload the disc and facet joints by load sharing. Survival against fatigue failure is the biggest challenge for PDS device because of the need for continued motion for an indefinite period. It should have a uniform load sharing throughout the range of motion.

Follow up of the present study showed that dynamic screw stabilisation has satisfactory clinical and radiological results for the treatment of lumbar disc degenerative disease as compared to rigid stabilization systems including the pain indices and radiological indices.

Rigid fixation systems have numerous disadvantages. Rigid instrumentation-associated complications, such as risk of pseudoarthrosis (15-96%) [7], facet and disc degeneration , adjacent segment disease because of the stress-shielding properties (2-3% per year after stabilization) [8], device-related osteopenia [9], worsened biomechanical properties of the spinal ligaments [10], morbidity and mortality risk with donor area pain, loss of motion in treated spinal segments. The absence of controlled motion makes the rigid system tend to fracture at the bone-implant interface because of increased surface stress [11]. The surgery for dynamic screw stabilisation is simpler than for rigid stabilization; there is little bone and ligament damage as compared to rigid stabilization. The dynamic system may be removed and fusion performed in case of unsuccessful outcome.

Dynamic stabilization devices are a recent technological development in the last two decades. Their theoretical success is based on immobilization of the injured segment to protect it from further injury, and sharing of load across the bridged segment. The aim of dynamic stabilization devices is to control neutral posture of the segment, control sagittal plane bending of the treated level, unload the intervertebral disc at the treated level, and modify the distribution of loads within the segment at the level of the intervertebral disc[12].

The fulcrum assisted soft stabilization (FASS) system was improved which was based on the same technique as the previous ones [13]. The second generation Dynamic Stabilization System (DSS II) was developed which unloads the disk by sharing 25% of the load off the disk at full flexion and extension [14]. The first dynamic hinged screw system was developed as a stable and nonrigid implant with calcium phosphate coated and hinged screws to maintain limited flexion and extension capability during stabilization [15]. The hinged screw of the Cosmic system prevents rotation, translational instability and screw loosening as compared to the previous systems.

Although follow up was relatively short in the current study (average six months), The VAS and ODI scores of the patients decreased significantly follow-up compared to preoperative scores in both the case series The pain analogue scale (ODI & VAS) showed significant improvement in Dynamic fixation as compared to the rigid fixation group . Adjacent disc degeneration was seen in both the groups however was more in the rigid fixation. Lumbar and segmental lordosis angles were maintained.

CONCLUSION

This posterior dynamic screw fixation appears to be a good alternative to rigid stabilization. In a series of cases a retrospective study comparing dynamic screw stabilisation with rigid screw of series of ten cases it has been seen dynamic screw stabilisation offers a better advantage over the rigid stabilisation and offers a better biomechanics of screw placement than rigid stabilisation as compared to decrease in the pain score objectively in both the groups.

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