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Research Article

Outcome Of Decompression in Lumbar Stenosis Using Spinous Process Splitting Approach

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Abstract

Aim of Study: The functional outcome following decompression surgery using the spinous process splitting approach, to assess the integrity of the paraspinal muscles after surgery and assess the fusion of the split spinous processes after they are sutured together

Material and Methodology

Preoperative plan: History was taken followed by clinical examination. Pre- operative scores were assessed Oswestry Disability Index(ODI), Japanese Orthopaedic Association(JOA) scoring system and Visual Analog Scale(VAS). Tests such as Tread mill test and electromyography studies of the involved segment were done. Radiographs of lumbosacral spine AP/lateral/flexion and extension views and MRI of spine were performed. Blood parameters CPK levels were done. Informed consent taken

Surgical Procedure: With the patient prone, the level of decompression is marked. The spinous process is split longitudinally in the middle and divided at its base from the posterior arch, leaving the bilateral paraspinal muscles attached to the lateral aspects. Ample working space for laminectomy is obtained by retracting the split spinous process laterally together with its attached paraspinal muscles. After successful decompression the two halves of the spinous process is re-sutured using a suture.

Post op protocol: Post operatively patients were evaluated for paraspinal muscle damage using CPK levels - 1hour and 48 hours post surgery. The patients were reviewed 1month, 3months and 6 months after surgery. The functional outcome was evaluated with Oswestry Disability Index, Japanese Orthopaedic Association scoring system, Visual Analogue Scale and a Tread-Mill test.

At 3 months the patients underwent electromyogram of paraspinal muscles. This was followed by a limited section computer tomography scan at 6 months to assess the fusion of the spinous process.

Results: Level of stenosis was most commonly seen at L3-L4 level. CPK levels compared to pre-operative, increased immediately during the post operative phase and started to decline by 48 hours. No change in the paraspinal muscles when compared between pre operative and 3 months post operative muscle status. Tread mill test showed the patient's duration of walking improved with time after the procedure. The patients walked for a greater duration at their own speed when compared to a fixed speed of 1.2mph after the surgical procedure. The patients assessed for pain showed that VAS increased post operatively but reduced with time. The functional outcome assessed using JOA score and the impairment of disability measured using ODI showed improvement.

Union rates were lesser in the above 50 age group though the functional outcomes were the same in whom spine was united and those with uniting spinous processes.

Conclusions: The lumbar spinal canal splitting approach offers the advantages of a wider surgical working space. The damage to the muscles and ligaments are minimal. Insignificant denervation of muscles was present. Union rates were higher in younger age group. Decompression achieved by this method was good in both unilateral and bilateral stenosis when involving one level.

Keywords: Decompression; Lumbar Stenosis; Spinous

Introduction

Stenosis is derived from a Greek word which means narrowing. Degenerative lumbar canal stenosis [1]. is a clinical condition resulting from narrowing of the spinal canal predominantly affecting older people. The general incidence of symptomatic stenosis ranges from 1.7% to 8% [2]. The most likely causes are facetal arthritis and the resulting osteophytes, hypertrophy of the ligamentum flavum and bulging of the intervertebral disc are responsible for encroaching on and narrowing the lumbar spinal canal [1].

Lumbar canal stenosis typically causes pain in the legs on standing and walking and is relieved by sitting and this is referred to as neurogenic claudication. In addition, patients may have back pain and may also develop motor and sensory deficits in lower limbs. As a result, walking distance can be significantly restricted leading to disability and diminished quality of life.

The surgical aim of treatment for symptomatic lumbar canal stenosis is relief of symptoms by adequate neural decompression while preserving much of the anatomy and biomechanical function of the lumbar spine. Numerous surgical approaches have been described ranging from conventional laminectomy, laminotomy, wide laminectomy [1] with undercutting of the medial facet along with foraminotomy to latest interspinous devices [3]. The disadvantage of a laminectomy or laminotomy through the midline (involving subperiosteal elevation of the paraspinal muscles) are the associated post-operative morbidity in the form of post-operative pain, denervation of the paraspinal muscles and prolonged recovery with delayed return to activity. In conventional laminectomy bilateral paraspinal muscles are dissected and detached extensively from the process and the laminae, the posterior ligament and spinous process are removed. The frequent surgical failures have been attributed to local tissue trauma and atrophy of para spinal muscles following such extensive soft tissue dissection in conventional approach of elevating the para spinal muscles. A spinous process splitting approach has been described that obviates the need to elevate the paraspinal muscles from their bony attachment [4]. The remaining decompression of the neural structures is the same as in the conventional approach. At the end of the surgery, the spinous processes are sutured back thereby restoring the anatomy.

There is a paucity of data to justify this technically demanding procedure. The aim of this study is to study the functional outcome following decompression surgery for lumbar canal stenosis using the spinous process splitting approach, to assess the integrity of the paraspinal muscles after surgery and the fusion of the split spinous processes post suturing.

The aims of the study are

- To analyse the functional outcome following surgical decompression for degenerative lumbar canal stenosis using the spinous process splitting approach.
- To study the extent of paraspinal muscle damage following the spinous process splitting approach
- To assess the fusion of the spinous process following the spinous process splitting approach

Material and Method

Study population

The data was collected from inpatients who were admitted for undergoing lumbar spinal canal stenosis decompression by spinous process splitting approach at the Hospital from August 2010 to December 2012. The average age group was 52.6 years with a range of 37 - 76 years. 22% of the patients were female and 78% were male.

Sample size and sample technique

We included a total of 38 patients for the study. But only 32 consented to undergo the procedure of spinal canal stenosis decompression by spinous process splitting approach.

Inclusion criteria

- Patients undergoing spinal decompression surgery for degenerative lumbar canal stenosis at one or more levels as diagnosed by clinical symptoms of bilateral neurogenic claudication with/without neurological deficits and MRI evidence of spinal canal narrowing.
- Age group between 30-80 years.

Exclusion criteria

- Age above 80 yrs or below 30 years
- Presence of spondylolisthesis more than grade 1

- Isthmic or lytic spondylolisthesis
- Patients undergoing instrumented or non-instrumented fusion.
- History of prior lumbar spinal surgery
- Presence of diabetic peripheral neuropathy
- Presence of systemic and local infections.
- Mentally ill patients.
- Poorly motivated and reluctant patients.
- Presence of cervical myelopathy
- Non-ambulant patients.
- Presence of vascular claudication
- Presence of hip and knee arthritis
- Inability to perform treadmill-test due to various other medical or surgical conditions

Methodology of study

Preoparative plan

- History was taken verbally
- Clinical examination
    - Range of motion of the spine
    - Straight leg raising test
    - Neurological evaluation - Motor power, sensations and reflexes.
    - Peripheral pulses in lower limbs - Dorsalis pedis and Posterior tibial pulses.
- Pre- operative scores
    - Oswestry Disability Index (ODI)
    - Japanese Orthopaedic Association (JOA)scoring system
    - Visual Analog Scale (VAS)
    - Tread-mill test (TMT)
    - Electromyography studies of the involved segment
- Imaging
    - Radiograph of lumbosacral spine AP/lateral/flexion and extension views
    - MRI of lumbosacral spine
- Blood parameters
    - Creatinine phosphokinase (CPK) levels - preoperatively, 1 hour post operatively and 48 hours post operatively

Informed consent will be taken after explaining the surgical procedure and potential intra-operative and peri-operative complications.

Surgical procedure

With the patient lying prone, the level of decompression is marked using a C-arm. The spinous process is split longitudinally in the middle and then divided at its base from the posterior arch, leaving the bilateral paraspinal muscles attached to the lateral aspects. Ample working space for laminectomy is obtained by retracting the split spinous process laterally together with its attached paraspinal muscles. After successfully decompressing the spinal canal and neural structures, the two halves of the split spinous process is re-sutured using a strong suture. Thus, the supra- and interspinous ligaments are preserved, as is the spinous process.

Post op protocol

Post operatively patient will be evaluated for paraspinal muscle damage using Serum CPK levels, 1hour post surgery and 24 hours post surgery to assess the post operative para spinal muscle damage. The patient will be reviewed 1month, 3months and 6 months after surgery. The functional outcome will be evaluated with ODI score, JOA score, VAS score and a Tread-Mill test.

At three months, the patient undergoes a repeat electromyogram of the paraspinal muscles. This was be followed by a limited section computer tomography (CT) scan at the end of 6 months to assess the fusion of the spinous process will be assessed using scan.

Data analysis

The information collected regarding all the selected cases were recorded in a Master Chart. Data analysis was done with the help of computer using Epidemiological Information Package (EPI 2010) developed by Centre for Disease Control, Atlanta and Excel software.

Results and Discussion

General

Lumbar canal stenosis is a frequent indication for surgery in elderly symptomatic patients. Traditional clinical outcome measures are also deficient in many areas. A wide range of outcome indicators has been used to study such patients. Each has major limitations so we used more than one parameter for the assessment of functional outcome consisting of various methods of imaging, psychologic testing, disability status and findings of neurologic examinations.

Patients were observed over a period of 6 months. A total of 32 patients were analysed. Functional outcome was assessed by JOA scores, disability was assessed using ODI scores and pain was evaluated using VAS Score. The patients were also assessed by TMT test according to a standardised protocol in which total ambulation time was measured at 1.2mph and at patients walking speed to assess for time to develop claudication.

The amount of para spinal muscle damage was assessed physical as well as biochemically. Physical was done by electromyogram of the para spinal muscles - done pre operatively and 3 months post operatively whereas biochemical assessment was done by serum CPK levels preoperatively, immediate post operatively and 48 hours post operatively.

At the end of 6 months patients underwent a CT scan to assess the extent of union in the split spinous process.

Figure 1: Patient 1 - 37 yr old male with L4 and L5 canal stenosis.

Pre - operative x rays.

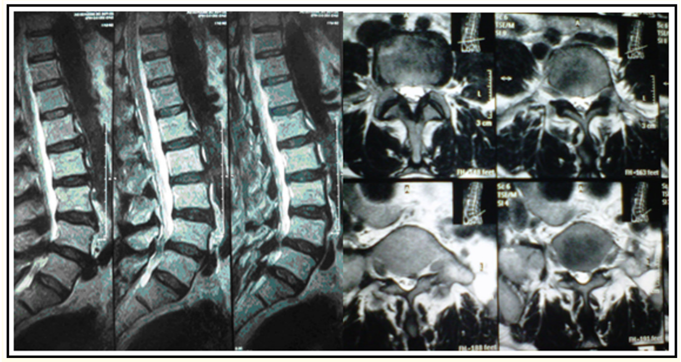
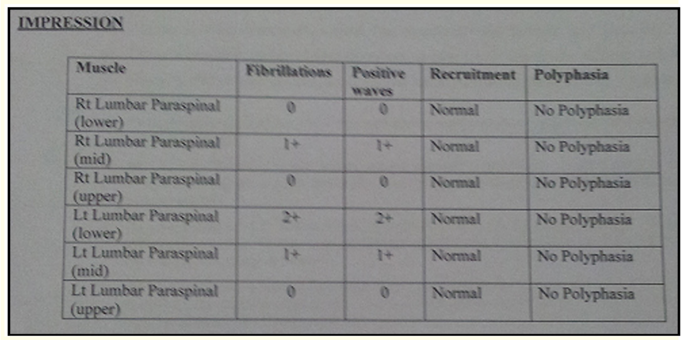


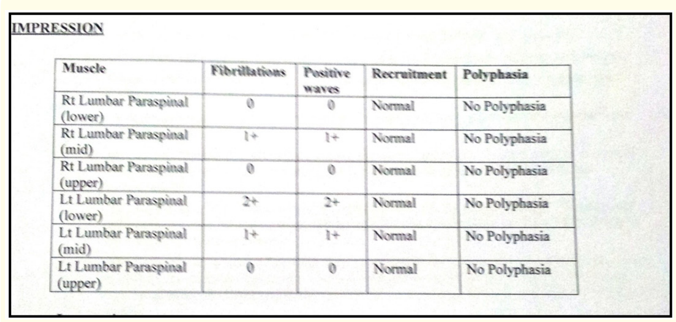
Figure 2: Preoperative Magnetic Resonance Imaging scans.



IMPRESSION

Muscle	Fibrillations	Positive waves	Recruitment	Polyphasia
Rt Lumbar Paraspinal (lower)	0	0	Normal	No Polyphasia
Rt Lumbar Paraspinal (mid)	1+	1+	Normal	No Polyphasia
Rt Lumbar Paraspinal (upper)	0	0	Normal	No Polyphasia
Lt Lumbar Paraspinal (lower)	2+	2+	Normal	No Polyphasia
Lt Lumbar Paraspinal (mid)	1+	1+	Normal	No Polyphasia
Lt Lumbar Paraspinal (upper)	0	0	Normal	No Polyphasia

Figure 3: Preoperative Electromyogram.



IMPRESSION

Muscle	Fibrillations	Positive waves	Recruitment	Polyphasia
Rt Lumbar Paraspinal (lower)	0	0	Normal	No Polyphasia
Rt Lumbar Paraspinal (mid)	1+	1+	Normal	No Polyphasia
Rt Lumbar Paraspinal (upper)	0	0	Normal	No Polyphasia
Lt Lumbar Paraspinal (lower)	2+	2+	Normal	No Polyphasia
Lt Lumbar Paraspinal (mid)	1+	1+	Normal	No Polyphasia
Lt Lumbar Paraspinal (upper)	0	0	Normal	No Polyphasia

Figure 4: At 3 months Electromyogram.

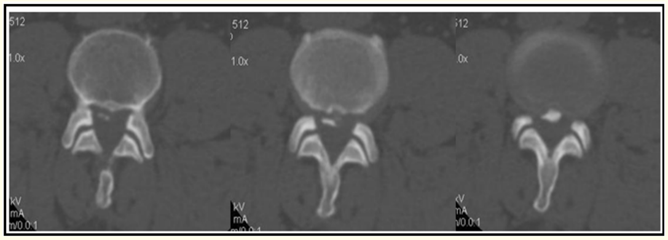


Figure 5: At 6 months Computed Tomography scan - union of spinous process.

Patient demographics

In this study of 32 patients, 37.5% (n = 12) of them were in the age group between 41 - 50 years. This was followed by the age group of 60 - 70 years. The average age for presentation was found to be 53. Among the 32 patients treated by spinous process splitting approach, 25 were male and 7 were female. This variation in age and sex distribution is comparable to the Indian literature by Nath [30]., *et al*. in 2012 where there is average age was 45.1 yrs males were 22 females were 10. When compared with international published data where male equals female in presentation at the out patient as quoted by J Abbas [50]., *et al.* in 2010, this variation in the presentation could be because of the ability of the male counterparts in India to get better care in comparison to the female counterparts in Indian families

Level and side of stenosis

On the evaluation of the levels involved in spinal canal stenosis, the most common level involved was that of L3-L4 which was approximately 43.8% (n = 14) of the study population. This was followed by L4 - L5 level with 28.1% (n = 9). Among the multiple levels involvement L4 - S1 was most common. This correlates with the study conducted by Goh KJ [32]., *et al.* at Oxford in 2004 where he reports the most common levels to be involved are L3 - L4 and L4 - L5. The above mentioned study of Goh KJ., *et al.* (2004) also states that central disc compression leading to bilateral claudication to be the most common in comparison to disc compression causing unilateral claudication pain. This is consistent with our study in which we had a maximum of 22 cases of the 32 which presented with bilateral claudication pain and central disc lesions.

Paraspinal muscle assessment - Role of CPK and electromyogram

The serum CPK values is used as a bio-chemical measure of extent of muscle damage during surgery preoperatively, with that of immediately post operatively and after 48 hours values. We found that there was an immediate increase in CPK values during post operative period which was probably due to the reason that the muscles were retracted along with the split spinous process. The serum CPK values had started to decrease by 48 hours which is evident by the mean value. These values are indicative that the procedure of spinous process splitting approach is less invasive as there is sparing of the paraspinal muscles. This when compared with the study conducted by Park BS [29]., *et al.* in 2010; showed a higher peak in those cases where conventional laminectomy was done when compared to a muscle sparing transmuscular microdiscectomy. The CPK levels preoperatively our values 4.07, immediately post operative was 5.45 and at 48 hours was 4.97 in our study had started to decline by 2^{nd} post operative day as compared to the muscle sparing and the conventional laminectomy approaches where the CPK levels continued to increase until the 3^{rd} post operative day and began to decline by the 5^{th} post operative day.

In comparison with the published data of paraspinal muscle denervation after conventional decompression procedures which have suggested para spinal muscle damage, the procedure of spinous process splitting approach showed no evidence of muscle atrophy at the end of 3 months when compared to the preoperative readings. This is evident when compared with the study by Datta G [28] in 2010, where needle EMG, preoperatively and post operatively showed evidence of denervation.

Tread mill test as a measure for claudication

Patients underwent tread mill tests to assess the duration for maximum ambulation possible at 1.2 mph and at patients walking speed. It was noticed that patients improved post surgically with the ability to walk on the tread mill with few completing 30mins. There was also an increase in duration on walking when patient was asked to walk at his preferred speed.

The patients with bilateral claudication had lower duration of walking on tread mill which averaged 6.34mins when compared to unilateral involvement where the average time was found to be 7.26 mins at 1.2mph and 7.73mins and 8.87mins respectively at patient speed in bilateral and unilateral cases. The tread mill test showed significant improvement compared to the preoperative scores but there was found to be no difference between the unilateral and bilateral groups in the final tread mill test with the duration of about 26mins achieved at 1.2mph and 28.2 mins on an average at patients speed. Thus concluding that decompression of the canal following spinous process splitting approach provided adequate decompression in both scenarios whether unilateral or bilateral.

The use of tread mill in this study emphasizes the fact that surgical intervention is of utmost importance in decompressing the lumbar spinal canal in order to improve the claudication distance as mentioned by Deen HG [12] in his study on "Test - retest reproducibility of the Exercise Treadmill Examination in Lumbar Spinal Stenosis" in 2000.

Assessment of patient outcome using scoring systems

The patients were assessed for pain and functional outcome using JOA Score for functional outcome and ODI for disability and impairment suffered by the patient. The patients VAS scores prior to surgery which showed a mean of 7.44 increased post operatively as this was a surgical procedure in which osteotomy of the bone was done. The VAS scores obtained post operatively showed a mean of 9.43. This in comparison to the previous studies by Park BS in 2010 showed lower VAS scores in the conventional laminectomy procedures in comparison to the muscle sparing surgeries. In comparison with the study done by Brock M., *et al*. in 2008, which showed decreased consumption of analgesics in the laminectomy group in comparison to the muscle sparing surgeries. Thus a spinous process splitting approach is associated with higher pain scores than conventional laminectomy. But at the end of study VAS score was comparable with conventional laminectomy group.

In our study we used the JOA scoring system [49] to assess the functional outcome of the surgery which showed an improvement between the preoperative scores and scores obtained at 6 months. This finding of an improved JOA scores is comparable to the study by Nath [30]., *et al*. in 2012.

The ODI scores which suggests disability due to disease and surgery [40] was compared and an improvement in the final scores were seen. The preoperative scores ranged from 32 to 42 with a mean of 37.2 and a mean of 15.7 at the end of 6 months.
This study in comparison to the study done by Brock M [24]., *et al*. in 2008 and Çavuşoğlu H [4]., *et al.* in 2007 is consistent.

The extent of spine union was assessed post operatively at the end of 6 months by taking limited section computed tomography scan at operated level. It was observed that spine union had occurred in 22 of the 28 patients which were present for the final follow up while 6 showed signs of callus formation but union was not present.

Among the 28 patients which followed up till the end of the study, we assessed them dividing patients according to age group, less than and more than 50. It was observed that there was only one patient with delayed union in age group less than 50, whereas 5 patients belonged to age group more than fifty. This is very significant finding in our study, even though there was not much significance in ODI, JOA and VAS score in both these groups, delayed union was of concern.

Extent of involvement of stenosis according to MRI whether bilateral or unilateral had no effects on the final functional outcome after surgery. The JOA scores and ODI scores were equal in both bilateral and unilateral groups. This concludes that the decompression by spinous process splitting approach, was adequate in both groups.

The age group less than 50 which included 15 patients of the 28 showed no difference between the JOA and ODI scores among the ones who had a united spinous process when compared to those with delayed union. In this same population group there was no difference in the ability to perform a tread mill test. In the study population above 50 years, it was noted that the JOA scores were better in the united group when compared to the patients with a delayed union. The ODI scores also proved to be similar as that of JOA scored with an improvement in the scores among those who had a united spine in comparison to those with delayed union. This same study group of above 50 years shows that there is an improvement in the treadmill times within the united and uniting groups between walking at constant speed of 1.2mph and at patients' preferred walking speed. The patients who had union of spine showed better walking durations at the end of 6 months in comparison to the group who had delayed union.

Conclusions

- The lumbar spinal canal splitting approach offers the advantages of a wider surgical working space and optimised visualisation while producing less muscular damage.
- The damage to the muscles and ligaments are minimal. Post surgically denervation of muscles were not seen as confirmed by serial CPK levels and paraspinal needle electromyogram.
- Post operative pain is more in this approach as suggested by elevated VAS scores during the immediate post - op period, long term pain due to muscle damage decreases
- This method of decompression is ideal in younger age group since union following splitting of spinous process and the functional out come were comparatively better.
- Decompression achieved by this method was good in both unilateral and bilateral stenosis, as suggested by improved JOA scores and walking distance post operatively. The results are comparable with decompression achieved by conventional laminectomy

Hence it may be concluded that decompression of canal by this approach is a valid alternative to conventional laminectomy where morbidity is higher.

Recommendations

- A similar study of a larger population is required in order to validate and compare the study with published results.
- This procedure should be avoided in old, osteoporotic patients as we know with increase in age union of bone is not good.
- Immobilisation of spine by using KT brace for 4 to 6 weeks might improve union rate of split spinous process in this surgeries, evaluation of union by a CT scan should be done earlier at 6 weeks to assess whether union is progressive or not.
- Using the same approach, other surgeries of spine like scoliosis listhesis should be done and the outcome analysed with published data
- Tread mill test assesses the improvement in claudication distance thereby indirectly assessing the adequacy of decompression therefore it should be done in all cases of spinal canal decompression.

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