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Factors affecting motor recovery after decompression of severe lumbar canal stenosis in patients with motor deficit.

Study design: Prospective study-observational

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Purpose: Very few prospective studies are available on the surgical outcome in patients with lumbar canal stenosis having a motor deficit. The study was aimed at evaluating factors affecting recovery of neurological deficits in cases of lumbar disc herniation (LDH) treated by lumbar decompression.

Methods A prospective study was performed at J.K. Hospital and Research Centre, Bhopal, M.P. India, from November 2019 to November 2021, on 35 patients. These patients present to us with complaints of weakness in ankle dorsiflexors (ADF) and extensor hallucis longus (EHL). In our study, all those patients were included who gave positive consent, who have L4 and /or L5 nerve root involvement innervating the anterior compartment of the leg and those who have lower extremity (ADF and EHL) weakness resulting from lumbar degenerative diseases like lumbar canal stenosis due to ligamentum flavum hypertrophy, facet arthropathy, disc protrusion and spondylolisthesis at L4-L5 level or L5-S1 level. Postoperative evaluations of motor recovery were performed regularly on an outpatient basis, and the results of the latest follow-up were analyzed. The follow up was done at 2 weeks, 12 weeks and 24 weeks in our OPD.

Result: 22(67.8%) patients having duration of symptoms less than 3 months had 95% recovery, group with duration of symptoms more than 3 month showed recovery rate of 70%. Recovery rate of 90% in ODI score in group with duration of symptoms less than 3 months. Following Kaplan and Meier analysis median time to foot drop improvement

was within 12 weeks of surgical decompression. After the Kaplan and Meier plot, we observe that maximum recovery is seen between 9 and 14 weeks after decompression.

Conclusion: Better improvement is seen if the patient got operated on within 3 months of neurological deficit. Also, it is observed that those patients with mild to moderate motor weakness show better recovery. Younger patients of less than 50 years with single level involvement show better recovery. We have observed preoperative muscle strength and duration of palsy as a significant prognostic indicator of better outcome following surgical lumbar decompression

Keyword: motor recovery, lumbar canal stenosis, neurological deficit, microscopic lumbar decompression.

INTRODUCTION:

Degenerative spinal condition causes anatomic narrowing of the vertebral canal termed as **Spinal Stenosis,** coined by **H. Verbiest**, of which lumbar spinal stenosis is most common.[1] Any structural pathology in this area will lead to spinal canal stenosis like disc degeneration and protrusion, ossification of posterior longitudinal ligament, ligamentum flavum hypertrophy, arthropathy of facet joints, tumour, infection trauma etc. The altered anatomy and pathophysiology in spinal stenosis was well illustrated by **Kirkaldy-Willis** through degenerative cascade in the lumbar spine responsible for lumbar canal stenosis.[2] As the space surrounding the neurovascular tissue becomes narrower, clinical symptoms may appear, such as neurogenic intermittent claudication (also known as pseudo-claudication), symptoms of radiculopathy (like radiating pain, tingling, numbness, burning sensation) in the lower extremities, motor weakness and with or without the complains of low back pain and urination– defecation impairment. The compression to nerve root induces numbness as result of ischemia whereas radiating pain is due to minor mechanical deformation to a chronic irritated nerve root.

MATERIALS AND METHODS:

A prospective study was performed at J.K. Hospital and Research Centre, Bhopal, from November 2019 to November 2021, on 35 consecutive patients. These patients present to us with complaints of weakness in ankle dorsiflexors (ADF) and extensor hallucis longus (EHL) with or without other symptoms of low back pain, symptoms of radiculopathy in

lower limbs (like tingling, numbness, burning sensation, radiating pain), intermittent claudication, etc. due to lumbar degenerative conditions, and were treated. In our study, all those patients were included who agreed for study enrollment, who have L4 and /or L5 nerve root involvement, who have lower extremity (ADF and EHL) weakness resulting from lumbar degenerative diseases like lumbar canal stenosis due to ligamentum flavum hypertrophy, facet arthropathy, disc protrusion and spondylolisthesis at L4-L5 level or L5-S1 level. All those patients are excluded who refused for [3]study participation, patients with peripheral nerve injuries like peroneal nerve, patients with cauda equina syndrome, patients with a previous history of palsy/paresis due to cerebrovascular accident, intraspinal tumours or cystic lesions of the lumbar spine like facet joint cysts, acute ligamentum flavum hematoma[3], patients with tibialis anterior (ankle dorsiflexor) and /or extensor hallucis longus weakness, any associated conditions which can alter the postoperative outcome like concurrent (tandem) cervical and lumbar stenosis known as Tandem Spinal Stenosis (TSS)[4] or patients lost to follow up. Demographic and clinical features of the patients at the time of presentation was evaluated. The diagnosis was established based on history including ODI score, physical examination including objective evaluation of motor strength of ADF and EHL using MRC grading by two independent examiners. MRI findings of lumbar spine based on the affected nerve root area, anteroposterior canal diameter, Kemp sign of sedimentation, hypointense area indicative of loss of epidural fat loss on T2-sagittal view. The level of involvement can be identified on clinical examination, which is further confirmed by MRI of the lumbosacral region. Preoperatively all patients had received trial of conservative treatment. All patients were admitted and got operated at J.K. Hospital, Bhopal. All patients underwent a physical examination in OPD and day before surgery. Depending on the aetiology patient underwent decompression surgery at the desired site. The indications for operative treatment were pain that causes significant functional disability and which had not been relieved by conservative treatment and a progressive neurological deficit.[5] Depending on the aetiology surgery for spinal stenosis consists of either decompression alone or decompression with spinal fusion. Decompression by laminectomy is the treatment of choice for central or lateral recess stenosis, or bilateral micro-decompressive laminatomy (MDL) can be done with fewer complications of

postoperative instability.[6] We took a posterior midline approach with the patient in supine position over two bolsters, one at the level of nipple and the other at the level of the iliac crest and head over the head frame with meticulous padding over the eyes and bony prominences.[7] Patients stayed in the hospital for an average 3 days after surgery. Postoperative evaluations of motor recovery were performed regularly on an outpatient basis, and the results of the latest follow-up were analyzed. All examiners were trained orthopaedic surgeons. Each patient was evaluated in follow by two independent orthopaedic surgeons, of which one is specialized in spine surgery. The follow up was done at 2 weeks, 12 weeks and 24 weeks in our OPD.

INCLUSION CRITERIA

1) A patient gives positive consent
2) All operations must include L-4 and /or L-5 nerve roots.
3) Patients with the duration of symptoms not more than 6 months.
4) Lumbar decompression for lower extremity weakness, mainly tibialis anterior (ankle dorsiflexor-ADF) and extensor hallucis longus (EHL) resulting from degenerative lumbar disease.

EXCLUSION CRITERIA

1) Patients refuse study enrollment.
2) All patients with peripheral nerve injuries (peroneal nerve) are excluded.
3) Patients' loss to follow up.
4) Patients with cauda equina syndrome.
5) Previous history of hemiplegia due to cerebrovascular accidents.
6) Associated conditions which will alter postoperative assessment, e.g., Cervical or dorsal myelopathy, tandem spinal stenosis etc.
7) Patients with Tibialis anterior or Extensor Hallucis Longus injury.

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TOOLS FOR PATIENT EVALUATION

Validated evaluated measures used for assessment are-

a) Modified Oswestry disability index

b) Manual assessment by medical research council (MRC) scale

c) Magnetic resonance imaging (MRI)

A. Modified oswestry disability index(mODI)

Jeremy Fairbank et al. 2000, did a meta-analysis and compared the four versions of one of the most versatile, valid and vigorous measures of condition-specific disability, the ODI score and **recommends the use of version 2.0. i.e., modified ODI, made by a Medical Research Council group** in the United Kingdom. He observed improvement in 32 patients, undergone spinal stenosis decompression with 2 years follow up, demonstrated on the Oswestry questionnaire correlated with decreased pain observed on the Visual Analog Pain scale. We used the modified ODI, where section 8 (sex life) is not included in our study. All patients were subsequently instructed to duly answer the ODI questionnaire.[8] The questionnaire contained six statements (denoted levels 0 to 5) in each of the 9 sections related to impairments like pain, and abilities such as personal care, lifting, walking, sitting, standing, sleeping, social life and travelling. In each section, the patient chose the statement that best described his/her status. If the limitation fell between two levels, the higher point value was selected. The chosen statements received scores 0 to 5 corresponding to the level indicated. The total scores could range from 0 (highest level of function) to 45 (lowest level of function). Upon adding up all of the points, the total score was divided by 45 and multiplied by 100 to calculate the percentage disability: **Total Points/ 50 X 100 = % Disability**

Hirotaka Haro 2007 et al. did a retrospective analysis and recommended ODI remained a valid, vigorous, and worthwhile measure of surgical outcome.[9]

B. Medical research council (MRC) scale

Muscle strength is assessed with the help of the Medical Research Council scale where power less than 3/5 for tibialis anterior is considered as foot drop. The recovery of ADF and

EHL power was defined as the difference between their power at the time of the latest follow-up and the preoperative power.

This manual assessment was done by two trained orthopaedic surgeons, of which one is an orthopaedic spine surgeon.

C. Magnetic resonance imaging (MRI)

MRI is an imaging modality of choice to identify the level and extent of spinal canal stenosis. On sagittal T1- weighted images are used for evaluation of foramen. An absence of normal fat around the root indicates foraminal stenosis.[10] Extraforaminal stenosis is identified on axial T1-weighted images by obliteration of the normal interval of fat between the disc and nerve root. As intervertebral foramen contains Dorsal root ganglion (7 mm in diameter) suspended by extraforaminal ligaments (thick), and intra-foraminal ligaments (thin) prevents DRG excursion. DRG contains somatostatin & substance P. Decompression of the dorsal root ganglia by removing the medial third of the apophyseal joint can result in satisfactory relief in pain in 70% of patients.[24] The cross-sectional area of the dural sac to be a more reliable diagnostic measure and defined cross-sectional areas of greater than 100 mm^2 at the narrowest point as normal, 76 to 100 mm^2 as moderately stenotic, and less than 76 mm^2 as severely stenotic.[11] Taking into account the high correlation, a sagittal diameter more than 10 mm was defined as normal, 8 to 10 mm as moderately stenotic, and less than 8 mm as severely stenotic.

OBSERVATION AND RESULT

1. Sex distribution

In our study of total 35 patients were included, of which 21 patients were male, i.e., 60 % and 14 were females, i.e., 40% of the total. Male: female ratio is 3:2. **Out** of 35 patients, 21 patients (60%) were male, and 14 patients (40%) were female. Of these 35 patients, 30 patients (85.7%) recovered.

2. Age

The mean age of 49 ± 13.1 years with {C.L. (95%) =4.5}, which ranges from 26 years to 85 years, majority of patients lie between 46 years to 60 years, i.e., 48 %. Twenty-one patients (60 %) are below 50 years, and 14 patients (40%) are above 50**.** 20 patients of 21 patients, with less than 50 years of age recovered, resulting in a 95% of recovery rate in

this group and 10 patients of 14 patients with age more than 50 years recovered, shows recovery rate of 71 % in this group. After comparing these groups with the outcome, the p-value calculated is 0.04, which is less than p-value < 0.05; thus, our result from this comparison is significant.

3. **Preoperative duration of symptoms**

With the mean preoperative duration of weakness 11.4 ± 7.5 weeks {CL (95%) 2.58}, 22 patients (62.8%) have symptoms of less than/ equal to 3 months of which 21 patients show recovery, thus, 95% recovery rate in this group, and rest 13 (37.2%) patients are having symptoms of more than 3 months, of which 9 patients show recovery rate of 69 % in this group. After comparing these groups with the outcome, the p-value calculated is 0.03, which is less than p-value < 0.05; thus, our result from this comparison is significant.

4. **Level involvement**

Based on MRI findings, 26 patients (74%) have single-level involvement, and 9 patients (26%) have multiple level involvement. Out of 26 patients having single level involvement, 25 patients shows recovery, whereas those with two or more level involvement, only 5 patients show recovery, and 4 patients (44.4%) patients show poor recovery. The p-value calculated after this comparison came out to be 0.002, which is much less than the p-value of 0.05; thus, our finding is significant.

STATISTICAL ANALYSIS OF PROGNOSTIC INDICATORS

A. Modified Oswestry Disability Index

After surgery, there is a gradual improvement seen in the ODI score. In our study, the mean preoperative ODI score is 25.65 ± 7.5 {C.I. (95%) 2.6} with a minimum of 15 scores and a maximum of 44 scores, with average ODI score is higher in females as compared to males. Gradual improvement is seen in the ODI score, which is 17.17 ± 5.6{CI (95%)1.9} at two weeks, 10.34 ±6{CI (95%)2} at 12 weeks and 5 ± 4.2{CI (95%) 1.4} at 24 weeks. average of 25.65 ± 7.6 with {CL (95%) =2.6}, which begins within 1 week postoperatively & gradually improves further. Two male patients do not show much improvement in ODI score, having ODI scores of 21 and 17 respectively after 6 months follow up. The ODI score of those patients with preoperative duration of

symptoms < 3 months shows improved ODI score with early & better recovery rate of about 90%, whereas patients with duration of symptoms of >3 months also show improved ODI (11+/-2) score but delayed recovery rate of about 82%. In our study, 9 patients, of which 7 were males and 2 were females, had an ODI score was less than 18 but still got operated. These nine patients are those patients who have a progressive motor deficit with short durations of symptoms of less than 1 month. All these 9 patients show good improvement both in ODI score and MRC scale.

B. Preoperative muscle strength

The mean preoperative strength of ADF is 4.2 ± 0.72 {CL (95%) =0.25}. Similarly, the mean preoperative strength of EHL is 3.7± 0.71 {CL (95%) = 0.24}.

The mean ADF muscle strength improved from 4.2 (range, 3−4) preoperatively to 4.68 (range, 3−5) postoperatively, with a significant p-value of 0.0002. Total 22 patients with ADF weakness, of which five patients have muscle strength of grade 3 and 17 patients have muscle strength of grade 4 as per the

MRC scale. The mean EHL muscle strength improved from 3.67 (range, 2−4) preoperatively to 4.51 (range, 3−5) postoperatively. Complete recovery was seen in 16 patients (72%). Grade 1 recovery from muscle strength of grade 3 to grade 4 (incomplete recovery) is seen in 2 patients (10 %). No recovery is reported in 4 patients (18%) (one patient with grade 3 and three patients with grade 4). Thirty-three patients present with EHL weakness, of which two patients have muscle strength of grade 2, nine patients with grade 3, twenty-two patients with muscle strength of grade 4. Complete recovery was noticed in twenty-two patients (65%). Grade 1 improvement is seen in 6 patients (17%) from grade. 3 to grade 4 muscle strength, one patient (3%) shows two grade improvement, i.e., from grade 2 to grade 4, five patients (15%) show no improvement of which four patients are having grade 3 muscle strength and one with grade 2 muscle strength as per MRC scale. As per MRCS, one-grade improvement is seen in 86% of the patients. No improvement is seen in five patients (14%). The majority of these patients are those who have a duration of symptoms of more than six months.

One grade improvement in power is seen on the MRC scale postoperatively after 10-15 days of decompression in patients with power 4/5 as per the MRC scale. Both male & female

shows significant improvement with an 87% recovery rate in males & a 78% recovery rate in female. This study also shows a

significant difference in neurological recovery with a different preoperative duration of symptoms. Those patients having preoperative symptoms of less than 3 months duration shows better and quicker recovery.

Following an adjusted Kaplan–Meier analysis, the median time to foot drop improvement was within 12 weeks of surgical intervention. After the Kaplan Meier plot, we observe that maximum recovery is seen between 9 weeks and 14 weeks, thus this finding suggest that maximum and better recovery occurs

around the first 12 weeks postoperatively.

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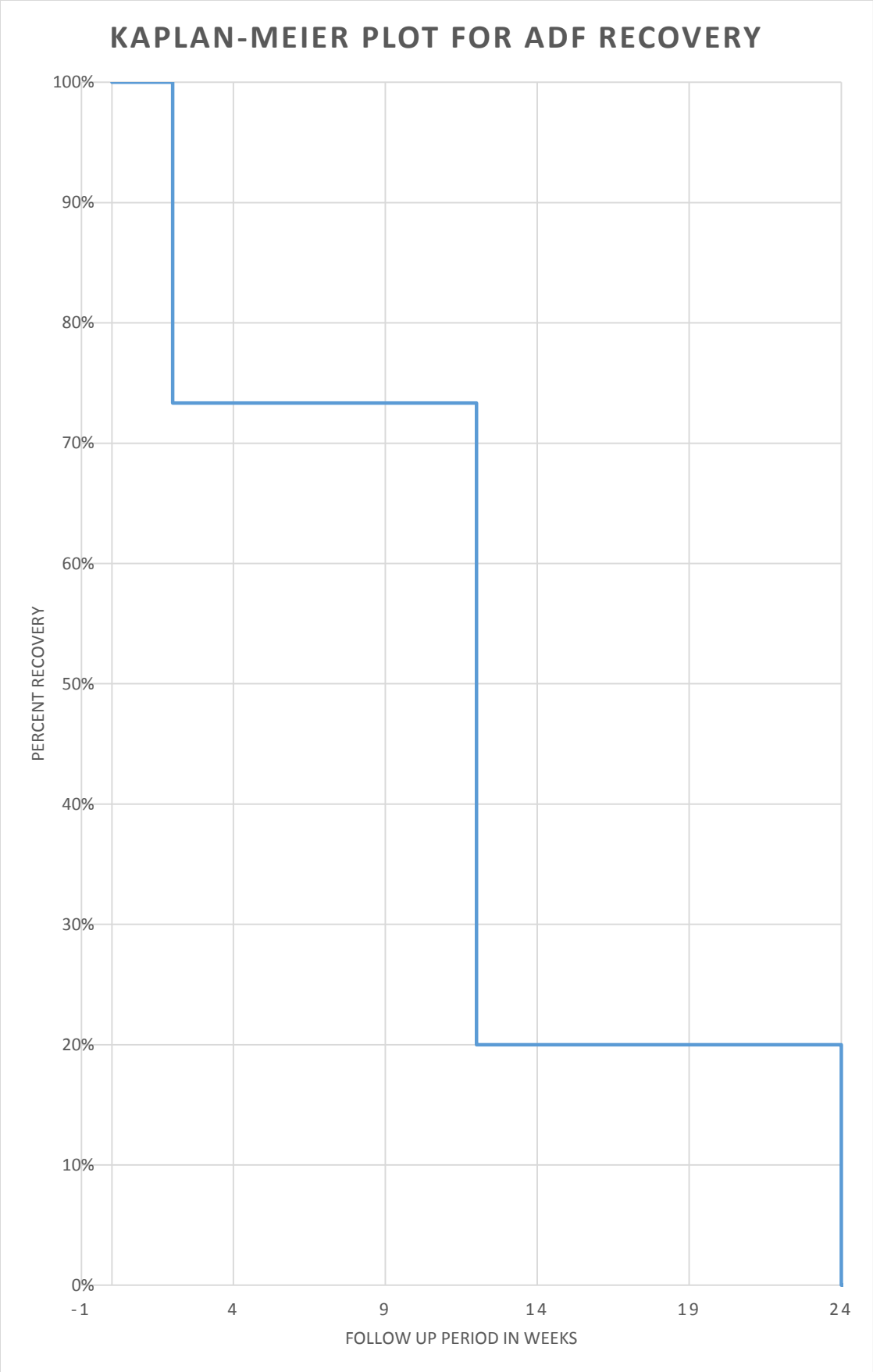
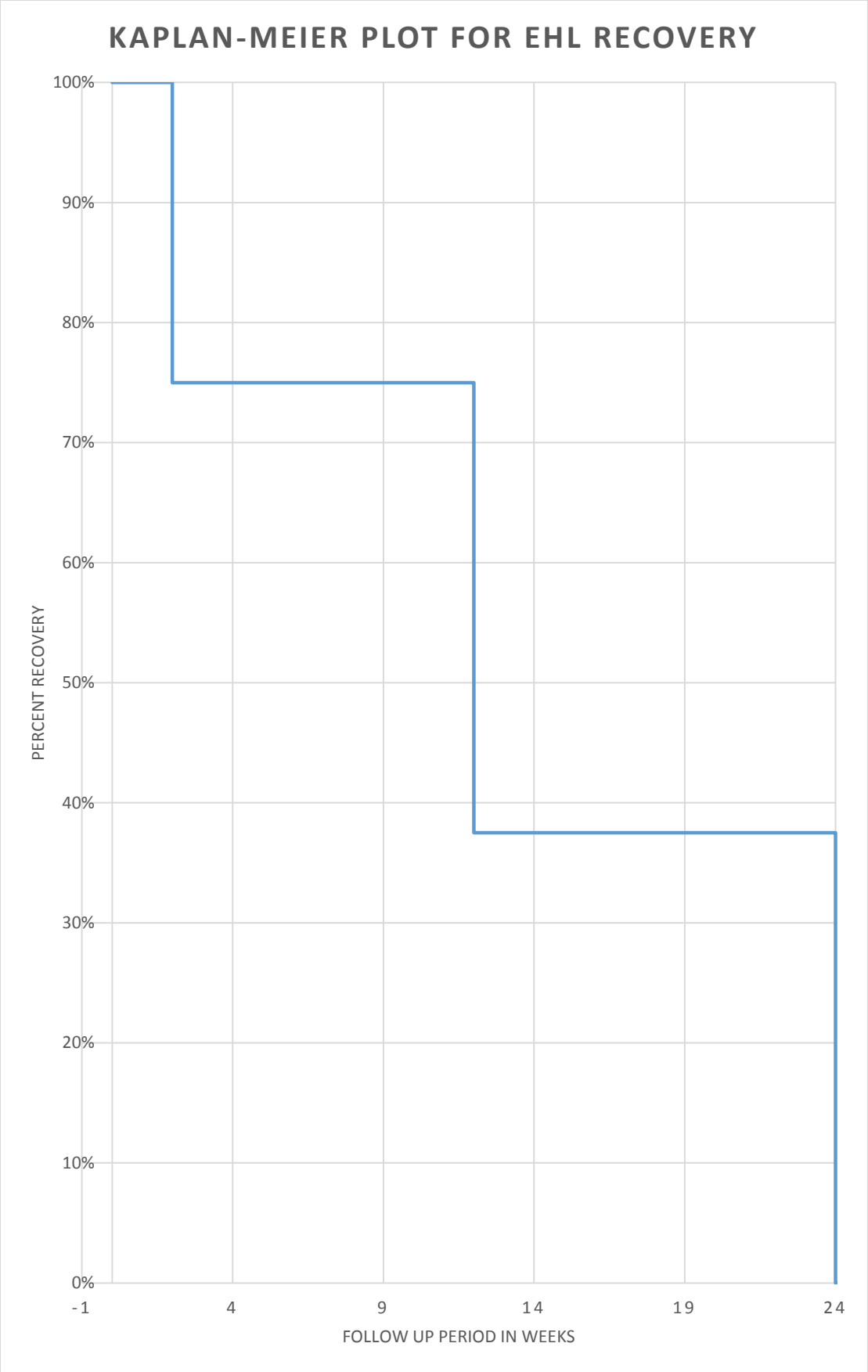


ISSN 2515-8260 Volume 09, Issue 07, 2022



COMPLICATIONS[20]

One patient had delayed wound healing with a superficial infection. This patient was reoperated at the surgical site. Thorough debridement and wound wash were given, and closure was done by approximating the two edges, which healed up within time.

KEY POINTS

This is a prospective study of 35 cases in the Department of Orthopaedics, L.N. Medical College and J.K. Hospital, Bhopal, from November 2019 to November 2021.

This study tried to analyse the following:

- The **pattern of motor recovery** after surgical decompression of lumbar canal stenosis involving L4 ± L5 and the factors which affect the prognosis of recovery-

1. The relationship between **the age** of patients at the time of surgery and recovery pattern.
2. The relationship between the **duration of symptoms** and recovery pattern.
3. The relationship between **the level of segments involved** and recovery pattern.
4. The relationship between the **preoperative muscle strength** and recovery pattern

CONCLUSION

In patients with lumbar spinal stenosis with neurological deficit undergoing operative decompression, the majority of patients experienced significant improvement in their muscle strength and disability, which correlates with the improvement in MRC and ODI scores. Better improvement is seen if the patient got operated on within 3 months of neurological deficit. Also, it is observed that those patients with mild to moderate motor weakness show better recovery. Younger patients of less than 50 years with single level involvement show better recovery. We have observed preoperative muscle strength and duration of palsy as a significant prognostic indicator of better outcome following surgical lumbar decompression, with age and level of spinal segment involved as an

indirect positive prognostic indicator. Our study does not demonstrate any relationship between sex distribution and outcome. The better recovery is observed in the first three months postoperatively.

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