

A Comparative Study to Assess the Advantages of Preservation of Posterior Ligamentous Complex in Decompressive Surgeries for Lumbar Spinal Canal Stenosis

Suresh Sivadasan Pillai¹, Asif Hassan K.²

¹Department of Orthopaedics, Travancore Medicity Medical College Hospital, Kollam, Kerala, India.

²Department of Orthopedics, Aster Mims Hospital Calicut, Kerala, India.

ABSTRACT

BACKGROUND

In this study we wanted to test hypothesis that posterior ligament complex preserving decompression has advantages over conventional decompression surgeries for the treatment of lumbar canal stenosis, assess clinical and functional outcome following decompression surgeries whether preservation has advantages over routine decompression and use radiological parameters pre operatively and post operatively to evaluate whether there is adjacent segment degeneration following decompression surgeries for canal stenosis.

METHODS

This is a prospective study conducted among in-patient and outpatient follow ups of the Department of Orthopaedics of MIMS Hospital, Calicut, over a period of 22 months from February 2017 to November 2018.

RESULTS

The mean age of patients included in the study in PLC preserved group was 58.68 ± 11.3 years and in PLC non-preserved group, it was 62.75 ± 11.18 years. There was a slight female predominance in PLC preserved group (60 %) and in PLC non preserved group male to female ratio was 1:1 At 1 year follow up both the groups of patients had significant relief of symptoms and had improved functional outcome. At 1 year follow up ODI and VAS score were better in PLC preserved group compared with PLC not preserved group. There was adjacent segment disc height improvement in both the groups, and was maintained in the PLC preserved group while during the final follow up there was slight reduction in the mean disc height in PLC not preserved group. Intervertebral disc angle and total lumbar lordosis in both the groups were comparable during 1 year follow up. Adjacent segment slip was not noted in both the groups. Adjacent segment degeneration was not detected in both the groups.

CONCLUSIONS

Lumbar decompressive surgeries with both PLC preserving and non-preserving surgeries can provide significant relief of symptoms to the patient. PLC preserving surgeries provide better functional outcome during the 1 year follow up period. Similarly residual pain was also less in the PLC preserved group. Adjacent segment degeneration was not detected in both the groups during the one year follow up.

KEY WORDS

Posterior Ligamentous Complex, Decompressive Surgeries, Lumbar Spinal Canal Stenosis

Corresponding Author:

Dr. Suresh Sivadasan Pillai,
Senior Consultant Spine Surgeon,
Department of Orthopaedics,
Travancore Medicity Medical College
Hospital, Kollam, Kerala, India.
E-mail: sureshorth@gmail.com

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BACKGROUND

As we age, the spine changes, often leading to a degeneration of the vertebrae (bones), discs, muscles and ligaments (connective tissues) that together make up the spinal column.¹ This condition is particularly common in aged or those with degenerative spine disease.² Spinal stenosis is a narrowing of the spinal canal or neural foramina producing root ischemia and neurogenic claudication.³ The causes for spinal canal stenosis are:

Bony Structures

- Facet osteophytes
- Uncinate spur
- Spondylolisthesis
- Soft tissue structures :
- Herniated or bulging discs
- Hypertrophy or buckling of the ligamentum flavum
- Synovial facet cysts

Degenerative changes that are part of aging process may lead to compression of neurologic tissues within the spinal canal. This compression occurs slowly and gradually affects the blood supply (arterial inflow and venous outflow).³ The typical symptoms of lumbar spinal canal stenosis include low back pain, sciatica, numbness and intermittent claudication,⁴ all of which may lead to functional deficits.⁵ Treatment options for lumbar canal stenosis may be surgical or non-surgical.⁶

Non-surgical treatments, such as physical and pharmacological therapy were reported to be effective for promoting symptom relief in 15-43% of patients.⁷ However surgery is indicated in patients who do not respond to conservative treatment.⁸ Indeed, most patients with extensive lumbar canal stenosis undergo surgery to alleviate symptoms and improve function.⁹

Objectives

1. To test hypothesis that Posterior ligament complex preserving decompression has advantages over conventional decompression surgeries for the treatment of lumbar canal stenosis
2. To assess clinical and functional outcome following decompression surgeries whether preservation has advantages over routine decompression.
3. To use radiological parameters pre operatively and post operatively to evaluate whether there is adjacent segment degeneration following decompression surgeries for canal stenosis.

METHODS

This is a prospective study conducted among in-patient and outpatient follow ups of the Department of Orthopaedics of MIMS Hospital, Calicut, over a period of 22 months from February 2017 to November 2018.

Inclusion Criteria

- 1) Disabling back pain or leg pain with or without neurological symptoms with lumbar canal stenosis confirmed on MRI scan
- 2) Radiological and clinical follow up of 1 year

Exclusion Criteria

- 1) Congenital bony lesions of the spine
- 2) Acute spinal fracture
- 3) Infection
- 4) Mass lesion in the spine
- 5) History of rheumatologic diseases

Sample Size

Total of 80 patients, 40 patients underwent PLC preserving laminectomy, decompression, instrumentation and posterolateral fusion while the other 40 underwent the same procedure without preserving PLC. Sample size is calculated using the equation $n = 2 \sigma^2 * (Z\alpha + Z\beta)^2 \delta^2$

We fix α as 0.05 (5 %) β as 0.20 (20%) so that power $(1 - \beta)$ is 80 %.

Previous study (outcome after surgery of lumbar spinal stenosis: A randomized comparison of bilateral laminotomy, trumpet laminectomy and conventional laminectomy) shows the average ODI score in the conventional laminectomy treatment group was 28 with a SD of 12. No previous data available on PLC preserving laminectomy.

For detecting a reduction of 3 score in ODI in the PLC preserving laminectomy, the sample size required is 30. Considering a lost to follow up of 20 % a sample of 36 is required per group. So we will include sample of 40 / group.

Method of Measurement of Outcome of Interest

Patients are randomly allotted in to two groups using MS EXCEL between (1,2), group 1 undergoing PLC preserving decompressive surgeries and group 2 undergoing decompressive surgeries without retaining PLC, for lumbar canal stenosis. This method of randomization could not be followed strictly as in some cases intraoperative decisions were taken to remove the supraspinous ligament due to its poor quality or there was accidental rupture of ligament.

Statistical Methods

VAS score, ODI score were considered as primary outcome variables. Disk height, IV disk angle, total lumbar lordosis parameters were considered as secondary outcome variables. Surgical Approach group (PLC preserved Vs PLC not preserved) was considered as Primary explanatory variable. Age, gender were considered as study relevant variables.

Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency and proportion for categorical variables. Non-normally distributed quantitative variables were summarized by median and interquartile range (IQR). Data was also represented using appropriate diagrams like bar diagram, pie diagram and box plots.

All Quantitative variables were checked for normal distribution within each category of explanatory variable by using visual inspection of histograms and normality Q-Q plots. Shapiro-wilk test was also conducted to assess normal distribution. Shapiro-wilk test p value of >0.05 was considered as normal distribution.

For normally distributed age, disk height parameter the mean values were compared between study groups using Independent sample t-test (2 groups). For nonnormally distributed ODI, VAS, IV disk angle, total lumbar lordosis different time periods parameters, Medians and Interquartile range (IQR) were compared between study groups using Mann Whitney u test (2 groups). Categorical outcomes were compared between study groups using Chi square test. P value < 0.05 was considered statistically significant. IBM SPSS version 22 was used for statistical analysis.¹

RESULTS

A total of 80 subjects were included in the final analysis. Among the study population, 40 (50%) participants were PLC preserved group and 40 (50%) participants were PLC non-preserved group.

The mean age of subjects in PLC preserved group was 58.68 ± 11.3 years and in PLC Non-preserved group, it was 62.75 ± 11.18 years. The difference in the age between the two groups was statistically not significant (P Value 0.109). In PLC preserved group 24 (60%) were female and remaining 16 (40%) were male. In PLC non-preserved group 20 (50%) were female and remaining 20 (50%) were male. The difference in the proportion of surgical approach between gender was statistically not significant (P value 0.369).

There was no statistically significant difference between two groups in ODI preoperative, post-operative follow up (P> 0.05). Among the people with PLC preserved group, the median ODI at 6th week follow up was 14 (IQR 12, 18) and it was 17 (IQR 12, 24) in people with PLC not preserved group. The difference in the ODI 6th week follow up between surgical approach was statistically significant (P Value <0.05). Among the people with PLC preserved group, the median ODI at 3rd month follow up was 10 (IQR 8, 12) and it was 11 (IQR 8, 21.5) in people with PLC not preserved group. The difference in the ODI 3rd month follow up between surgical approach was statistically significant (P Value <0.05). Among the people with PLC preserved group, the median ODI at 6th month follow up was 8 (IQR 5, 10) and it was 8 (IQR 6, 19.5) in people with PLC not preserved group. The difference in the ODI 6th month follow up between surgical approach was statistically significant (P Value <0.05). Among the people with PLC preserved group, the median ODI at 1st year follow up was 4.5 (IQR 4, 7.5) and it was 7.5 (IQR 4, 18) in people with PLC not preserved group. The difference in the ODI 1st year follow up between surgical approach was statistically significant (P Value <0.05).

There was no statistically significant difference between two groups in VAS score pre-operative, post-operative follow up (P> 0.05). Among the people with PLC preserved group, the median VAS score at 6th week follow up was 3 (IQR 2, 3.75) and it was 3.5 (IQR 3, 5) in people with PLC not preserved group. The difference in the VAS score 6th week

follow up between surgical approach was statistically significant (P Value <0.05). Among the people with PLC preserved group, the median VAS score at 3rd month follow up was 2 (IQR 2, 2) and it was 3 (IQR 2, 5) in people with PLC not preserved group. The difference in the VAS score 3rd month follow up between surgical approach was statistically significant (P Value <0.05). Among the people with PLC preserved group, the median VAS score at 6th month follow up was 1 (IQR 1, 2) and it was 2 (IQR 1, 5) in people with PLC not preserved group. The difference in the VAS score 6th month follow up between surgical approach was statistically significant (P Value <0.05). Among the people with PLC preserved group, the median VAS score at 1st year follow up was 1 (IQR 1, 1) and it was 1 (IQR 1, 1.475) in people with PLC not preserved group. The difference in the VAS score 1st year follow up between surgical approach was statistically significant (P Value <0.05).

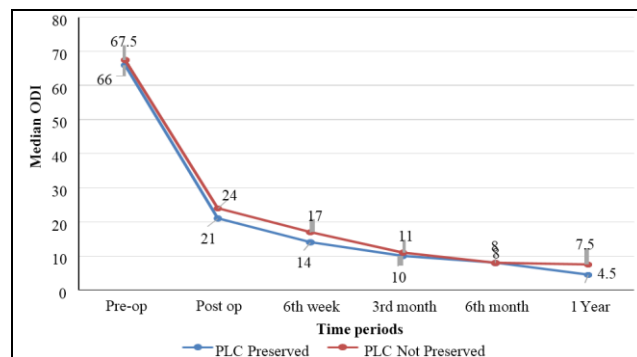


Figure 1. Trend line diagram of Comparison of ODI between the two groups at different follow-up time periods (N=80)

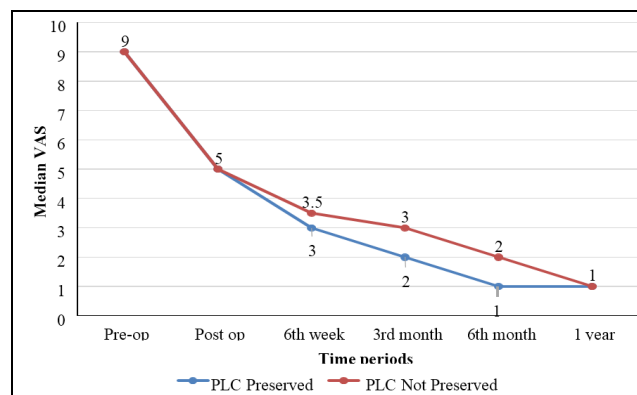


Figure 2. Trend line diagram of comparison of VAS between the two groups at different follow-up time periods (N=80)

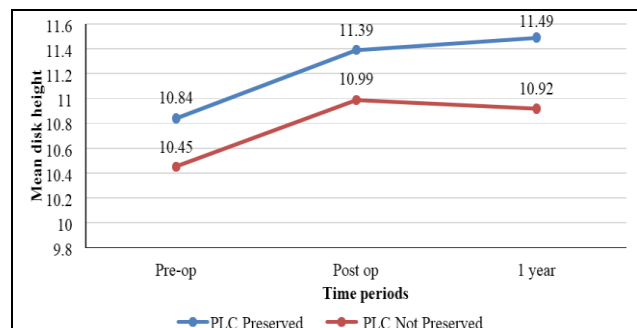


Figure 3. Trend line diagram of Comparison of Disc Height between the two groups at different follow-up time periods (N=80)

In the PLC preserved group the mean disc height was 10.84 ± 1.59 , immediate post op was 11.39 ± 1.51 and at 1 year follow up was 11.49 ± 1.53 . In the PLC not preserved group the mean disc height was 10.45 ± 1.82 , immediate post op was 10.99 ± 1.8 and at 1 year follow up was 10.92 ± 1.76 . There was no statistically significant difference between two groups in disc height pre-operative, post-operative and 1 year follow up ($P > 0.05$).

In the PLC preserved group the median IV disc angle of the adjacent segment was 6 (5, 7) in the pre op, 7 (6, 8) in the immediate post op and 7 (6, 8) at 1 year follow up. In the PLC not preserved group the median IV disc angle was 6 (5, 7) at pre op, 7 (6, 7) at immediate post op and 7 (6, 8). There was no statistically significant difference between two groups in IV-disk angle pre-operative, post-operative and 1 year follow up ($P > 0.05$).

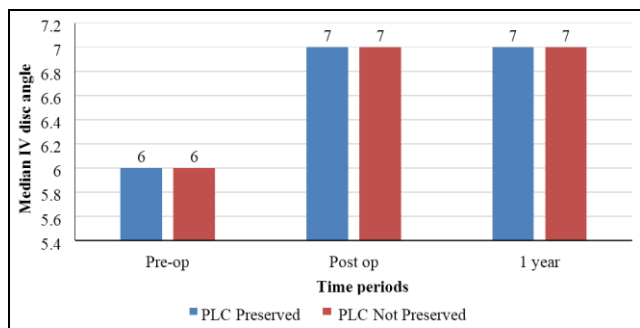


Figure 4. Clustered bar chart of comparison of IV-disc angle between the two groups at different follow-up time periods (N=80)

There was no statistically significant difference between two groups in total lumbar lordosis pre-operative, post-operative and 1 year follow up ($P > 0.05$).

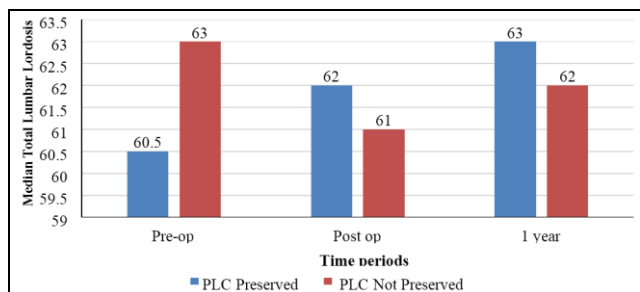


Figure 5. Clustered bar chart of comparison of total lumbar lordosis between the two groups at different follow-up time periods (N=80)

	Parameter	ODI Median (IQR)	P value (Wilcoxon signed Test)
PLC Preserved group	Pre-op	66 (62, 70.75)	(Base line)
	Post op	21 (17, 24)	<0.001
	6 th week	14 (12, 18)	<0.001
	3 rd month	10 (8, 12)	<0.001
	6 th month	6 (4, 8)	<0.001
	1 year	5 (4, 7.5)	<0.001
PLC Non-preserved group	Pre-op	67.5 (64, 74)	(Base line)
	Post op	24 (18, 26)	<0.001
	6 th week	17 (12, 24)	<0.001
	3 rd month	10 (8, 22)	<0.001
	6 th month	8 (6, 20)	<0.001
	1 year	6 (4, 18)	<0.001

Table 1. Comparison of median values of ODI within the group at different follow up periods (N=80)

In PLC preserved group, the median ODI score was 66 (62, 70.75) at preoperative, 21 (17, 24) at post-operative, 14 (12, 18) at 6th week follow up, 10 (8, 12) at 3rd month follow up, 6 (4, 8) at 6th month follow up and 5 (4, 7.5) 1st year follow up.

The differences in the ODI score at post-operative, 6th week, 3rd month 6th months and 1st year follow up period with baseline value (pre-operative) were statistically significant (P value <0.001). In PLC not preserved group, the median ODI score was 67.5 (64, 74) at pre-operative, 24 (18, 26) at post-operative, 17 (12, 24) at 6th week follow up, 10 (8, 22) at 3rd month follow up, 8 (6, 20) at 6th month follow up and 6 (4, 18) at 1st year follow up. The differences in the ODI score at post-operative, 6th week, 3rd month 6th months and 1st year follow up period with baseline value (pre-operative) were statistically significant (P value <0.001).

	Parameter	VAS Median (IQR)	P value (Wilcoxon signed Test)
PLC Preserved group	Pre-op	9 (8, 9)	(Base line)
	Post op	5 (4, 6)	<0.001
	6 th week	3 (2, 3.75)	<0.001
	3 rd month	2 (2, 2)	<0.001
	6 th month	1 (1, 2)	<0.001
	1 year	1 (1, 1)	<0.001
PLC Non-preserved group	Pre-op	9 (8.25, 9)	(Base line)
	Post op	5 (4, 6)	<0.001
	6 th week	3.5 (3, 5)	<0.001
	3 rd month	3 (2, 5)	<0.001
	6 th month	2 (1, 5)	<0.001
	1 year	1 (1, 4.75)	<0.001

Table 2. Comparison of median values of VAS within the group at different follow up periods (N=80)

In PLC preserved group, the median VAS score was 9 (8, 9) at pre-operative, 5(4, 6) at post-operative, 3 (2, 3.75) at 6th week follow up, 2 (2, 2) at 3rd month follow up, 1 (1, 2) at 6th month follow up and 1 (1, 1) 1st year follow up. The differences in the VAS score at post-operative, 6th week, 3rd month 6th months and 1st year follow up period with baseline value (pre-operative) were statistically significant (P value <0.001). In PLC not preserved group, the median VAS score was 9 (8.25, 9) at pre-operative, 5 (4,6) at post-operative, 3.5 (3, 5) at 6th week follow up, 3 (2, 5) at 3rd month follow up, 2(1, 5) at 6th month follow up and 1 (1, 4.75) at 1st year follow up. The differences in the VAS score at post-operative, 6th week, 3rd month 6th months and 1st year follow up period with baseline value (pre-operative) were statistically significant (P value <0.001).

DISCUSSION

ODI Score

In both PLC retained and not, comparing with the base line values there was significant change in the ODI scores post operatively, i.e. there was much symptom relief and improved functionality in both the groups. In PLC preserved group the median ODI score was 66 (62, 70.75) at pre-operative, 21 (17, 24) at post-operative, 14 (12, 18) at 6th week follow up, 10 (8, 12) at 3rd month follow up, 6 (4, 8) at 6th month follow up and 5 (4, 7.5) 1st year follow up. In PLC not preserved group median ODI score was 67.5 (64, 74) at pre-operative, 24 (18, 26) at post-operative, 17 (12, 24) at 6th week follow up, 10 (8, 22) at 3rd month follow up, 8 (6, 20) at 6th month follow up and 6 (4, 18) at 1st year follow up. In a study by Haichun Liu to assess the outcomes following various surgical decompression techniques for spine, the clinical and functional outcome where assessed using JOA score. All the patients had satisfactory improvement/ alleviation of symptoms irrespective of the technique of surgery.¹⁰

Comparing between the groups the ODI score in PLC preserved groups were better compared to the PLC not preserved group, stating that PLC preserved decompression surgeries have better functional outcome during the 1 year follow up period. In the study by Haichun Liu et al comparing the different surgical decompression techniques with a follow up period of 5-7 years the initial functional outcomes were comparable in the three groups, but on long term follow ups outcomes of complete laminectomy group were poorer compared to the group which underwent facet joint resection using undercutting decompression preserving PLC.¹⁰

VAS Score

In both the groups comparing with the preoperative values there was significant reduction in VAS score. In the PLC preserved group the median VAS score was 9 (8, 9) at pre-operative, 5 (4, 6) at post-operative, 3 (2, 3.75) at 6th week follow up, 2 (2, 2) at 3rd month follow up, 1 (1, 2) at 6th month follow up and 1 (1, 1) 1st year follow up. In PLC not preserved group, the median VAS score was 9 (8.25, 9) at pre-operative, 5 (4, 6) at post-operative, 3.5 (3, 5) at 6th week follow up, 3 (2, 5) at 3rd month follow up, 2 (1, 5) at 6th month follow up and 1 (1, 4.75) at 1st year follow up. In a study done by Hadadi et al comparing the outcome of three different surgeries (bilateral laminotomy, trumpet laminectomy and conventional laminectomy), all the three groups had significant reduction in VAS score compared to the pre op values and there is increase in walking distance post op.¹

Comparing between the groups the VAS score in PLC preserved groups were better compared to the PLC not preserved group, stating that PLC preserved decompression surgeries have better pain relief during the 1 year follow up period. Also there was no statistically significant difference between two groups in VAS score preoperative and immediate post-operative follow up.

Disc Height

The disc height evaluation was done to assess mainly the adjacent segment degeneration. Most of the previous reports have principally described the cranial segment degeneration after fusion. The assessment was done only on the cranial segment. In the PLC preserved group the mean disc height was 10.84 ± 1.59 , immediate post op was 11.39 ± 1.51 and at 1 year follow up was 11.49 ± 1.53 . In the PLC not preserved group the mean disc height was 10.45 ± 1.82 , immediate post op was 10.99 ± 1.8 and at 1 year follow up was 10.92 ± 1.76 . There was no statistically significant difference between two groups in disc height pre-operative, post-operative and 1 year follow up. The evaluation reveals that there was improvement in the adjacent segment mean disc height/space following fusion procedures and is maintained in the PLC preserved group during the one year follow up period.

In the PLC not preserved group slight reduction in mean disc height was observed at the final follow up, but there was no significant reduction to be met for the criteria of ASD. In a study done by Haichun liu comparing three surgical decompression techniques during 5- 7 year follow up period, it was observed that the mean disc height was significantly

reduced in the group who underwent complete laminectomy with removal of PLC.¹⁰

IV Disc Angle

In the PLC preserved group the median IV disc angle of the adjacent segment was 6 (5, 7) in the pre op, 7 (6, 8) in the immediate post op and 7 (6, 8) at 1 year follow up. In the PLC not preserved group the median IV disc angle was 6 (5, 7) at pre op, 7 (6, 7) at immediate post op and 7 (6, 8). There was no statistically significant difference between two groups in IV-disc angle pre-operative, post-operative and 1 year follow up. In study by Haichun liu comparing three surgical decompression techniques during 5- 7 year follow up period it was observed that the adjacent segment IV disc angle was significantly higher at final follow up in all the three groups than at the time of the preoperative assessment. And it was also noted that the disc angle in group which underwent complete laminectomy was significantly higher than in the other 2 groups which underwent PLC preservation in group 1 and semi laminectomy in group 2 respectively.¹⁰

Total Lumbar Lordosis

In the PLC preserved group the median total lumbar lordosis at pre op was 60.5(58, 65.75), immediate post op was 62 (58.25, 64.75) and at 1year follow up was 63 (59, 65). In the PLC not preserved group the median total lumbar lordosis was 63 (56.25, 66), immediate post op was 61 (58, 66) and at 1 year follow up was 62 (59, 66). There was no statistically significant difference between two groups in total lumbar lordosis preoperative, post-operative and 1 year follow up. In study by Haichun liu comparing three surgical decompression techniques during 5- 7 year follow up period it was observed that there was significant reduction in lumbar lordosis in the group who underwent complete laminectomy without preservation of PLC.¹⁰

CONCLUSIONS

Lumbar decompressive surgeries with both PLC preserving and non-preserving surgeries can provide significant relief of symptoms to the patient. PLC preserving surgeries provide better functional outcome during the 1 year follow up period. Similarly residual pain was also less in the PLC preserved group. Adjacent segment degeneration was not detected in both the groups during the one year follow up.

Limitations

The small sample size and limited period of follow up were possible limitations of the study. Minimal alterations in radiological parameters might have occurred by even slight variations in position of the patients from the prescribed stance. As disability was assessed based on self-answered questionnaire about symptoms, subjective variations could have arisen.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.

Financial or other competing interests: None.

Disclosure forms provided by the authors are available with the full text of this article at jemds.com.

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