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Original Article

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Intra-operative Use of Platelet-Rich Plasma Augmentation in Lumbar Spine Surgery for Intervertebral Disc Prolapse- A Prospective Study

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ABSTRACT

Background: Lumbar disc prolapse is a major reason for radiculopathy and disability, which requires surgery in case of failure of conservative management. While discectomy provides decompression, recurrence and incomplete healing due to intra-operative complications like dural tear, etc., or post-operative complications like disc degeneration, epidural fibrosis, scar tissue formation, etc. are significant concerns. Platelet-rich plasma (PRP), rich in growth factors, offers enhanced regenerative efficacy and improves surgical outcomes by promoting tissue repair, thereby reducing inflammation.

Method: The study is a prospective observational study, which included 30 patients with lumbar disc prolapse who underwent discectomy. The preparation of the PRP was performed from the autologous blood, and the application was done intraoperatively. Patients were assessed for 6 months by the use of VAS, MODI, SLRT and some other clinical factors. Data analysis was done using SPSS with $p \leq 0.05$ for statistical significance.

Result: The findings evaluated that 41–60 years (73.3%) were most predominant, with unilateral radiculopathy accounted to be as 73.33%. Chronic symptoms (1–2 years) were noted among 63.33%. 46.67% was the involvement of L4–L5. Minimal postoperative complications were noted as 76.67%. Improvement was noticed for the SLRT (60° to 75–80°), VAS scores (9 to 1), and MODI scores, with the improvement of disability of 90% for 6 months.

Conclusion: The study concluded that the middle-aged patients showed chronic radiculopathy, while the surgery with PRP provided a minimal rate of complications with significant outcomes regarding pain, disability, and function.

Key-words: Lumbar disc prolapse; Platelet-rich plasma; Discectomy; Radiculopathy; Functional outcome

INTRODUCTION

Lumbar disc prolapse is one of the leading causes of sciatica and disability globally, and, when conservative treatment fails, it usually requires surgical intervention [1,2].

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Open microdiscectomy has consistently been shown to provide reliable decompression of the nerve root and has a long-lasting effect in relieving radicular pain; thus, it has become the benchmark for the treatment of lumbar disc herniation [1].

Open microdiscectomy addresses the mechanical compression and the biochemical inflammatory processes associated with nerve root injury, and it has remained a key component of modern treatment pathways [2]. Long-term patient-reported outcomes are similar for newer endoscopic techniques, but open microdiscectomy continues to demonstrate a long-established and low complication rate of 10–13%, and a

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recurrence rate of 4–5% [1, 2]. Therefore, it continues to be a reference standard method for restoring function in symptomatic patients [1,2].

Patients who undergo standard decompression may have a significant amnion defect (≥6 mm) and are thus susceptible to recurring hernias and accelerated degeneration of adjacent discs [3]. The inability of traditional discectomy to biologically close the annulus fibrosus or to restore hydration of the nucleus often places these patients at risk for failed back surgery syndrome [3,4]. While sequestrectomy may provide some increase in patient satisfaction long-term through preserving some disc/tissue, it does not provide the necessary elements needed to fill the healing gap [4]. Therefore, as new clinical recommendations continue to include the closure of annular defects for patients who are at high risk, the limitations of exclusively mechanical procedures will be substantially lessened [3,4].

Patients undergoing Spine surgery for Lumbar Disc Prolapse and related problems may have delayed rehabilitation due to intraoperative complications like Dural tear, CSF leak, and nerve injury, leading to a delay in the process of return to normal life. Post-operative complications like disc degeneration due to altered biomechanics of the spine, epidural fibrosis, scar tissue formation, etc., are also documented, causing the persistence of symptoms leading to Failed Back Syndrome. To overcome these complications, the use of intra-operative Platelet-rich plasma can be a viable option, knowing the fact about its regenerative and other multiple characteristics.

PRP is a novel therapeutic tool of autologous nature that has emerged strongly in recent years due to its successful therapeutic use. Autologous PRP is a concentrate of essential growth factors such as TGF-β, PDGF, and IGF-1 that facilitate regenerative processes [5]. The bioactive constituents of PRP promote tissue repair through stimulation of chondrocyte proliferation (growing new cartilage cells), enhancement of extracellular matrix synthesis (creating new connective tissue to support healed tissues), and initiation of new blood vessel formation (angiogenesis) [6]. PRP also creates an anti-inflammatory environment through M2 macrophage polarisation (conversion of macrophages from inflammatory to non-inflammatory), which promotes a metabolic environment conducive to healing [5,6]. Studies explore the role of PRP in stimulating tenocyte proliferation and collagen remodelling by releasing bioactive factors that improve the overall organisation of the extracellular matrix [7]. Reviews have demonstrated that PRP increases the migration of cells and vascularisation, but there is variability in clinical outcomes related to the use of different formulations of PRP and differences in the number of leukocytes present in each sample [7,8]. Despite this variation of clinical outcomes with PRP, it has been shown to have a favourable safety profile and can be considered an adjunct treatment option for patients with rotator cuff injuries, lateral epicondylitis, and for the performance of exploratory spinal procedures where targeted regeneration of tissue is desired [7,8].

The use of intra-operative PRP application delivers growth factors directly into annular defects during periods of increased inflammation. This method combines mechanical decompression with biological repair. Using an autologous source of PRP creates a "biological asset", eliminating potential for immunogenicity and possibly improving function after injury. This study will evaluate clinical outcomes, as well as radiographic effectiveness, of lumbar discectomy with the use of intra-operative PRP application.

MATERIALS AND METHOD

Study design- This was a prospective observational study for the usage of the use of platelet-rich plasma for lumbar spine surgery. The study was conducted in the Department of Orthopaedics in the ESI-PGIMSR & ESIC Medical College and Hospital, Joka, Kolkata. Those patients were included who had presented with low back pain due to the intervertebral disc prolapse (PIVD) and had attended the department of Orthopaedics OPD and Casualty. The study duration was 18 months (December 2022 to May 2024). A total sample size of 30 patients was included for the study, on the basis of the institutional surgical load and feasibility. All of the enrolled patients have undergone lumbar spine surgery along with the intra-operative PRP augmentation. This was followed by the investigation of the clinical and functional outcomes. Well-written and informed consent is required for the study. Predefined criteria were considered for the study.

Inclusion criteria

- ✓ Patients aged 30 to 60 years were included.

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- ✓ Those who did not respond to the conservative management system were not included.
- ✓ Patients with neuro-deficit symptoms were only included.
- ✓ Well-written informed consent was required for the study.

Exclusion criteria

- ✓ Prior history of spinal injury, fracture, or previous spine surgery, spinal or vertebral tumours; neurological disorders like movement of bowel content were not allowed for the study.
- ✓ Usage of corticosteroids and other pain interventions for 2 weeks of administration of PRP was not allowed for the study.
- ✓ Patients with local, spinal, or systemic infections were not allowed.
- ✓ Patients with medicolegal disputes related to back pain were not allowed.
- ✓ The platelet counts of <105,000/µL were not allowed.

Sample size- We can use the method of 'Purposive Sampling' to calculate the possible minimum sample size by the formula:

$$n = N/ (1+NE^2)$$

Where, n = sample size; N = population size
which is around 30 per year
E = error estimate, which is taken as 5%. So, n = 30/ (1+30*0.05*0.05) = 27.9 ≈ 28. So, the minimum possible sample size is 28.) However, an attempt was made to obtain data from 30 such cases in order to meet the large sample criteria.

Procedure- The study was a prospective observational study, which included 30 patients with intervertebral disc prolapse. All of the patients had undergone detailed clinical and neurological assessments, with routine evaluation and clinicoradiological diagnosis before the planned lumbar spine surgery according to the standard guidelines, before the counselling events. PRP was produced from 22 ml of venous blood for the production of ~6 ml PRP. Venous blood (22 ml) was drawn from one of the antecubital veins into one 30 ml tube (with 3 ml prefilled anticoagulant) on the day of surgery. This collected venous blood was centrifuged at 3400 RPM (revolutions per minute) for 6 minutes in the operating theatre to separate the components into different layers. The top layer (supernatant) consists of platelet-poor plasma. The lower half of the supernatant, just above the separator gel, consists of high concentrations of platelets, and it provided 6 ml of PRP (Fig. 1 and Fig. 2). During the procedure of surgery, 3 ml of PRP was injected into the disc space, and 3 ml was injected around the nerve roots, which was followed by the standard wound closure. Patients received analgesics, early physiotherapy, and were released within 3 to 5 days. Patient rehabilitation included the mobilisation with the necessary precautions for about 4 to 6 weeks. Follow-up was done for 6 months, with the assessments by the use of VAS, MODI, SLRT, and clinical examination. The demographic features, clinical characteristics, and other outcomes were recorded and analysed.

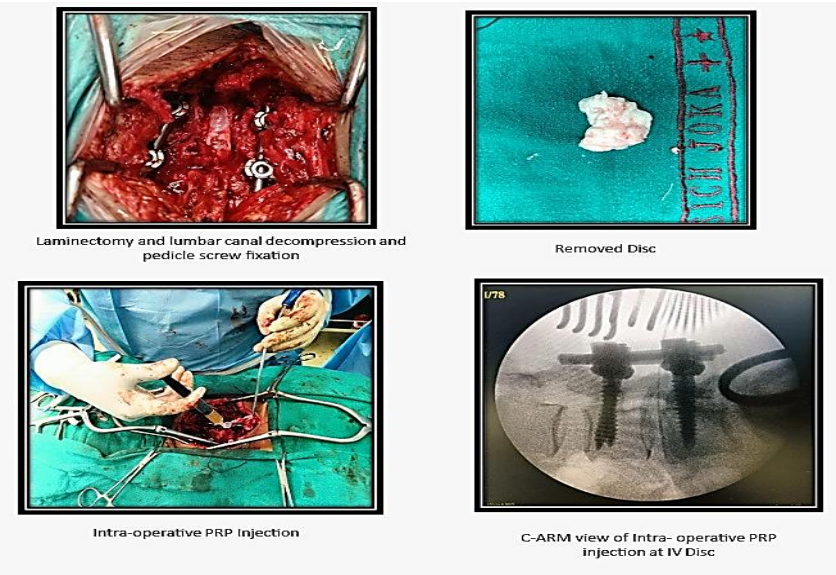

Fig. 1: Intra-operative procedure and components

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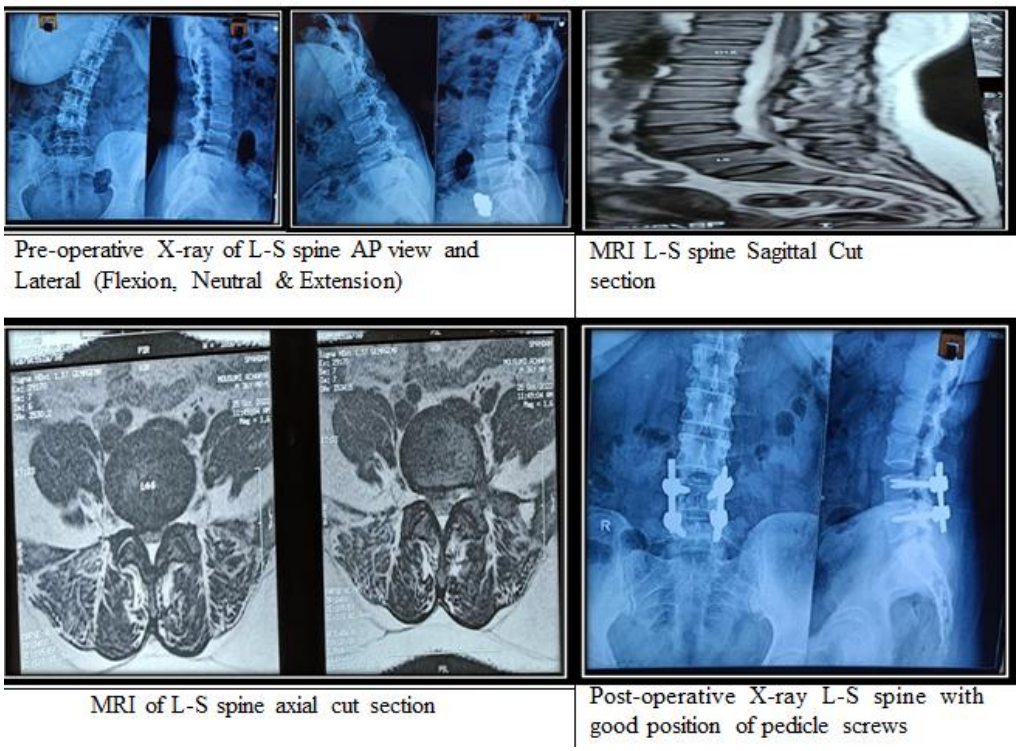

Fig. 2: The radiological assessment during the preoperative and postoperative period of the Lumbo-Sacral Spine by the use of X-ray and MRI Imaging

Statistical Analysis- Microsoft Excel and SPSS version 27.0, as well as GraphPad Prism version 5 were used for data analysis. Numerical variables were represented as mean ± standard deviation and frequencies and percentages were used for analysis of categorical variables. p-value ≤ 0.05 was considered for statistical significance.

RESULTS

Table 1 showed the predominance of the middle-aged population, with the highest group being 51–60 years (40.0%), which was followed by the 33.3% of 41–50 years. Also, young participants are rare (3.3%), which is directed towards older age groups. The mean age is 48.27±9.75 years, and the median was 48.5 years, which indicated a symmetric distribution. The age range between 28 and 70 years reflected the moderate variation. Balanced gender distribution was noticed, with females constituting about 51.6% and males 48.4%.

Table 1: The demographic parameter distribution and the age statistics among the study participants

Variable	Category	Frequency	Percentage	Mean	SD	Minimum	Maximum	Median
Age Group	≤30	1	3.30%	-	-	-	-	-
	31–40	5	16.70%					
	41–50	10	33.30%					
	51–60	12	40%					
	61–70	2	6.70%					
	Total	30	100%					
Age (Summary)	-	30	-	48.266	9.748	28	70	48.5
Sex	Female	16	51.60%	-	-	-	-	-
	Male	14	48.40%	-	-	-	-	-
	Total	30	100%	-	-	-	-	-

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Table 2 showed the most common presentation of the low back pain along with the radiculopathy of the right lower limb (43.33%), which was followed by the 30% of the left-sided radiculopathy. This indicated the predominance of the unilateral radicular symptoms. 13.33% of the bilateral radiculopathy was noted. The severe low back pain was noted among10% of cases, while the rare weakness of both lower limbs occurs among 3.33% of cases. The results stated that the radiculopathy consisted of major clinical presentations, which highlighted the involvement of the nerve root as the main pattern of complaint in this cohort.

Table 2: The distribution of the clinical complaints among patients

Complaint	Frequency	Percentage (%)
Low back pain with radiculopathy in the right lower limb	13	43.33
Low back pain with radiculopathy in the left lower limb	9	30
Low back pain with radiculopathy in the bilateral lower limbs	4	13.33
Severe Low Back pain	3	10
Low back pain with weakness in both lower limbs	1	3.33
Total	30	100

Table 3 represented the most reported symptoms and the duration of 1–2 years (63.33%), which had indicated the chronic presentation, with 16.67% cases of less than 1 year and (20%) of cases for >2 years. A functional assessment was performed, which showed preserved walking, standing and sitting ability, indicating symptoms of neurological claudication. Specifically, 46.67% of participants had difficulty in walking after ≤5 minutes, 26.67% had difficulty in walking after > 5-10 minutes, and 13.33% reported walking without any constraints. Standing is more hindered, as 6.67% of cases were observed to be disabled after standing for<= 5 mins, 20% after standing for >5-10mins, and 33.33% after standing for >10 mins, respectively. 66.67% reported no constraint regarding the sitting tolerance. Frequent disabilities regarding doing daily activities were noted among 5 patients, and 1 case of bladder and bowel incontinence was noticed.

Table 3: The distribution of the symptomatic duration and the functional limitation among patients

Variable	Category	Difficulty in Walking (Freq)	%	Difficulty in Standing (Freq)	%	Difficulty in Sitting (Freq)	%
Duration	<1 year	5	16.67	-	-	-	-
	1–2 years	19	63.33	-	-	-	-
	>2 years	6	20	-	-	-	-
	Minimum	1month	-	-	-	-	-
	Maximum	6 years	-	-	-	-	-
	Total	30	100	-	-	-	-
Functional Limitation	≤ 5 mins	14	46.67	2	6.67	1	-
	>5 – 10 mins	8	26.67	6	20	0	0
	>10 mins	4	13.33	10	33.33	9	-
	Nil	4	13.33	12	40	20	66.67
	Total	30	100%	30	100	30	100
Other Disabilities	Difficulty in doing activities of daily living	5	-	-	-	-	-

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	Bladder and bowel incontinence	1	16.67%	-	-	-	-
	Difficulty in riding motorcycles	1	3.33%	-	-	-	-

%= Percentage

Table 4 showed that patients who had undergone the laminectomy along with the partial discectomy and pedicle screw fixation, mostly observed in the L4–L5 level (46.67%), which was followed by 20% of the L5–S1. A substantial number of patients underwent multilevel fixation, with 23.34% of the two-level and the 3.33% of the three-level. These procedures indicated the limited involvement. 76.67% have reported no complication, while 10% showed urinary retention. This was followed by 6.67% cases of bladder and bowel incontinence and 3.33% of isolated bladder incontinence. Data suggested the single-level fixation in the case of the single-level fixation with a low rate of complication.

Table 4: The distribution of the surgical procedure and the associated Postoperative Complications

Variable	Procedure / Complication	Level of fixation	Number of levels of fixation	Frequency	Percentage (%)
Procedure	Laminectomy and partial discectomy with pedicle screw fixation	L3-L4	1	2	6.67
	Laminectomy and partial discectomy with pedicle screw fixation	L4-L5	1	14	46.67
	Laminectomy and partial discectomy with pedicle 2-screw fixation	L5-S1	1	6	20
	Laminectomy and partial discectomy with pedicle screw fixation	L3-L4-L5	2	2	6.67
	Laminectomy and partial discectomy with pedicle screw fixation	L4-L5-S1	2	5	16.67
	Laminectomy and partial discectomy with pedicle screw fixation	L3-L4-L5-S1	3	1	3.33
Complications	Urinary retention	-	-	3	10
	Bladder incontinence	-	-	1	3.33
	Bladder and bowel incontinence	-	-	2	6.67
	Bladder and bowel incontinence with foot	-	-	1	-
	Nil	-	-	23	76.67
	Total	-	-	30	100

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Fig. 3 demonstrated that major patients had experienced no postoperative complications, while 77% had shown favourable surgical outcomes. Out of all complications, only 10% of cases showed urinary retention, which was followed by the 7% of bladder and bowel incontinence. The isolated bladder incontinence and combined bladder and bowel incontinence with foot drop were rarely observed, each of which accounted for 3%. The overall rate of complication was low, with adverse outcomes being minor and infrequent, rather than the high rate of uncomplicated cases.

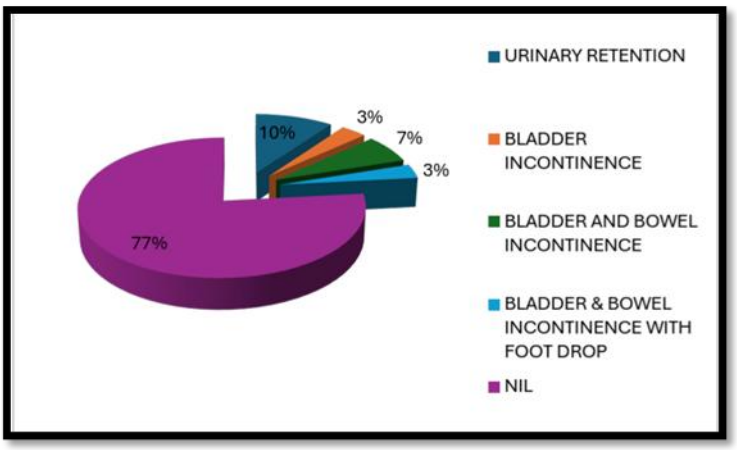

Fig. 3: The distribution of the postoperative complications among patients

Fig. 4 showed the consistent improvement, where the mean values of Passive SLR Test rose from ~60° preoperatively to ~75–80° at 3–6 months. The MODI score assessment was shown in Fig. 2 B, which marked the shift towards lower disability. 22 severe patients and moderate patients were 5 in number based on the MODI scale. A significant shift was observed by 3 months, with only 9 patients having moderate disability. Majorly, at the end of 6 months, 27 patients fell into the major group with the minimal/no disability category and the rest showed moderately disabled (3). The mean score of VAS showed a reduction from 9 at the preoperative stage to 5 at 1 month, which indicated the early postoperative improvement. This showed a reduction to 2 at 3 months and also 1 at 6 months, which reflected the pain relief.

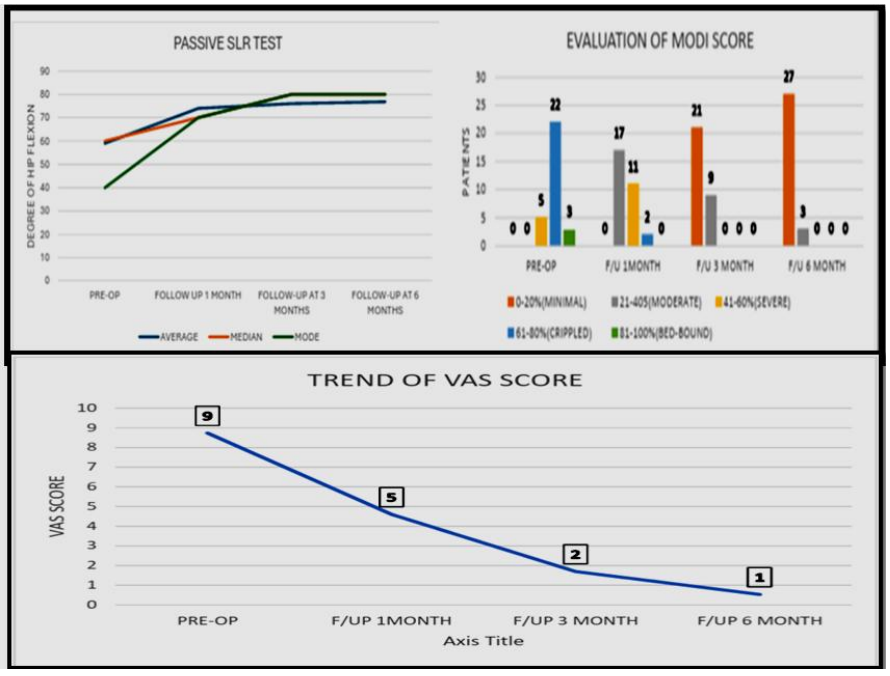

Fig. 4: The functional improvement over time, represented by the Passive SLR Test and MODI Score Assessment and the graphical representation of the Visual Analogue Scale (VAS) Scores across time intervals

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DISCUSSION

Studies show that using autologous PRP inside the disc may help patients who are undergoing endoscopic spinal surgeries. The aim of a randomized trial with 60 patients in 2024 was to determine the effectiveness of PRP within the discs versus standard surgical methods (surgery occurred at the same time with no PRP), measured by the visual analogue pain scale (VAS) and Oswestry Disability Index (ODI) score. Patients showed significant improvement from baseline at 3 days post-surgery, with 96.7% of patients having good or excellent outcomes [9]. The 2025 meta-analysis evaluated data from 433 patients; PRP augmentation resulted in significantly less back pain and disc height loss when compared to the standard surgical methods [10]. MRI results were also reviewed in both studies, and they demonstrated significantly greater recovery of Pfirrmann grades for the PRP augmented group (p=0.013 for the 2024 study; p=0.002 for the 2025 study) than for the non-augmented group; therefore, it appears that PRP has a positive effect in slowing degenerative changes to the disc without increasing complications associated with surgery [9,10].

A randomized interventional study of 60 patients was conducted to assess the perioperative placement of platelet-rich fibrin (PRF) as a way to decrease the incidence of neuropathic radiculopathy, the incidence of which is 30% following surgical intervention. To evaluate the efficacy of surgery with PRF augmented surgical procedures using VAS and NPSI score at six months as indicators of neurogenic inflammation and recovery of nerve function [11]. Furthermore, a meta-analysis involving 433 participants in six studies found that surgical procedures using both full endoscopic lumbar discectomies combined with PRP were associated with significantly lower rates for back pain and disc height loss ($p < 0.05$) compared to procedures performed without PRP or using other biological adjuncts. In addition, the studies reviewed showed a higher level of functional improvement and an increased number of participants receiving a Pfirrmann grade recovery ($p = 0.002$) for participants who had undergone a surgical procedure using biological adjuncts compared to participants who had undergone isolated decompression surgery [10].

A meta-analysis of eight studies and 717 patients was published in 2025. They found that when you combine percutaneous endoscopic lumbar discectomy (PELD) with PRP, clinical markers, including the VAS, ODI, and JOA scores, significantly improved compared with PELD alone. The treatment group had fewer recurrent herniations and demonstrated an increase in intervertebral disc height and the cross-sectional area of the spinal canal ($p < 0.05$) [12]. A retrospective analysis of 155 patients showed that the PRP group had significantly better outcomes than the non-PRP group at 3, 6, and 12 months for disc remodeling and grey scale ratio values. With excellent functional outcomes (93.3%), these findings demonstrate the efficacy of PRP for delaying disc degeneration and aiding in the structural recovery of the intervertebral disc over time [13].

Using PRP augmentation for lumbar discectomy has improved patient outcomes, producing significantly better VAS, ODI and JOA scores than standard procedures [10,14]. These types of meta-analyses have found that the biological assistance provided by PRP reduces rates of recurrence, preserves the height of the disc, and may lead to more complete symptomatic improvement while enhancing the potential for tissue remodelling [10]. Several randomized trials have provided early evidence of potential benefits from PRP postoperatively with regard to pain relief and improving Pfirrmann grades on MRI and not providing any additional adverse event compared to standard discectomy [9]. In addition, by cooperating with aiming for annular repairs and improving spinal canal metrics, the use of PRP will improve the surgical techniques that will be utilized to perform a biologically augmented discectomy and will continue to be safe and have a short recovery period after the procedure [9,10].

CONCLUSIONS

The study concluded that middle-aged individuals with a mean age of 48 years are mainly affected by chronic low back pain. The most common clinical presentation was the unilateral radiculopathy, which indicated the involvement of the nerve root as the main pathological feature. Most patients had long-term symptoms for 1 to 2 years with significant limitations, like standing and walking, while sitting was preserved. Surgical procedure, including the single-level laminectomy with partial discectomy and pedicle screw fixation, showed a significant outcome. Minimal postoperative complications were noticed, with 77% of cases experiencing no adverse events. Improvements were noticed in the case of functional mobility (SLR), disability

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(MODI scores), and pain reduction (VAS), with a recovery period of 6 months. The results supported that the surgical intervention is a safe and effective process and was related to the functional and symptomatic improvement among patients with chronic lumbar radiculopathy.

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