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Original Article

Evaluation of Therapeutic Potential of Platelet Rich Fibrin in the Healing Process of Small Central Tympanic Membrane Perforation using Endoholder

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Abstract:

Small central tympanic membrane perforations pose a clinical challenge, often leading to hearing impairment and reduced quality of life. Standard surgical repair may not be feasible for all patients. Platelet Rich Fibrin, an autologous biomaterial rich in growth factors, has emerged as a minimally invasive alternative to enhance healing. This study evaluates Platelet Rich Fibrin, applied via the Endoholder technique, for treating small central tympanic membrane perforations.

In this prospective interventional study, 35 patients (mean age: 37.7 ± 15.4 years) with dry, single-sided, small central tympanic membrane perforations were enrolled. Baseline assessments included otoscopy, pure tone audiometry, Weber and Rinne tests, Speech Discrimination Scores, and the Hearing Handicap Inventory for Adults. Platelet Rich Fibrin was prepared through centrifugation of autologous blood and applied to the tympanic membrane using an Endoholder under endoscopic guidance. Follow-up & patient satisfaction was assessed at one month.

A 94.3% success rate was observed, with complete tympanic membrane healing in 33 of 35 cases. Pure tone audiometry thresholds improved from 27.6 ± 6.9 dB to 12.3 ± 4.6 dB ($p < 0.001$), and the air-bone gap reduced from 15.4 ± 7.3 dB to 3.2 ± 1.8 dB ($p < 0.001$). Speech Discrimination Scores increased from 85.6% to 95.3% ($p < 0.01$), and Hearing Handicap Inventory for Adults scores improved significantly (14.3 to 1.8, $p < 0.001$). All patients reported no procedural pain, with a high satisfaction score (28.2/30).

Platelet Rich Fibrin, applied endoscopically via the Endoholder, shows promise as a minimally invasive treatment for small TM perforations, warranting further study.

Keywords: Tympanic membrane perforation, Platelet rich fibrin, Endoholder, Audiological improvement, Patient satisfaction, Regenerative medicine, Minimally invasive treatment.

Introduction:

Tympanic membrane (TM) perforations are a prevalent clinical concern in otolaryngology, affecting both the middle ear's structure and function, resulting in varying degrees of conductive hearing loss.[1] Common causes of TM perforations include chronic otitis media, trauma, and iatrogenic injury, all of which disrupt the TM's essential role in sound conduction and middle ear protection. Although small TM perforations can sometimes close spontaneously, larger and chronic perforations often necessitate surgical intervention,

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most commonly myringoplasty or tympanoplasty.[2] However, these procedures carry limitations, such as postoperative morbidity, risk of graft failure, and high costs, especially in resource-limited settings.[3] The development of minimally invasive and cost-effective alternatives has thus gained interest in recent years, with bioactive materials like Platelet-Rich Plasma (PRP) and Platelet-Rich Fibrin (PRF) emerging as promising adjuncts in regenerative medicine.[4,5]

PRF, derived from autologous blood, is a second-generation platelet concentrate rich in growth factors such as platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), and vascular endothelial growth factor (VEGF), all of which play crucial roles in tissue repair and angiogenesis.6 Unlike PRP, PRF requires no anticoagulants or external activation, allowing for a gradual release of growth factors that enhance wound healing over a more sustained period.[7] This distinction makes PRF particularly attractive for TM perforations, where controlled tissue regeneration is crucial for optimal healing outcomes.[8] Recent studies have explored the use of PRF in otologic applications, particularly in the context of chronic TM perforations resistant to conventional treatments.[9] For instance, Santos et al. demonstrated that PRF application significantly reduced closure time for TM perforations compared to traditional myringoplasty alone.[10] Additionally, PRF's ability to accelerate fibroblast proliferation and collagen deposition has been documented in both animal and human models, further underscoring its potential as a scaffold for tissue regeneration.[11]

However, the long-term efficacy of PRF in TM healing remains under investigation, with some studies indicating variability in outcomes based on perforation size and patient age.[12] Furthermore, advances in endoscopic techniques have facilitated the precise application of PRF in otologic procedures, reducing the need for larger surgical incisions and enabling outpatient management.[13] The use of endoholders in conjunction with endoscopy, as highlighted by Murugesan et al., allows for minimally invasive application of PRF to TM perforations, potentially reducing postoperative discomfort and enhancing patient satisfaction.[14] In this study, we employed endoscopic PRF application to evaluate its efficacy in the closure of small, chronic TM perforations, assessing outcomes related to hearing restoration, patient satisfaction, and overall quality of life.

Despite promising findings, there remains a need for well-designed, controlled studies to establish standardized protocols for PRF use in otolaryngology.[15] Current literature suggests that PRF's growth factor-rich matrix may provide an optimal environment for TM regeneration, potentially offering a low-cost, autologous alternative to traditional tympanoplasty.[16] With the growing emphasis on patient-centered care and minimally invasive techniques, the potential of PRF as a primary or adjunctive treatment for TM perforations warrants further exploration.[17] Thus, this study aims to fill the existing research gap by systematically evaluating the therapeutic potential of PRF in the healing of small, chronic TM perforations. The findings will provide valuable insights into the clinical application of PRF in otolaryngology and contribute to a more comprehensive understanding of its regenerative capacity in the auditory system.

Materials and Methods:

This research was a prospective interventional study conducted at Sir Salimullah Medical College Mitford Hospital to evaluate the therapeutic potential of Platelet-Rich Fibrin (PRF) in the healing process of small central tympanic membrane (TM) perforations. This study spanned from January 2024 to August 2024. A total of 35 patients, aged between 15 and 65 years, were enrolled in this study using a convenient sampling method. Inclusion criteria included individuals with a dry, small (Involving only one quadrant of TM), single-sided TM perforation, and a history of perforation duration between one month and three years. Informed written consent was obtained from all patients before inclusion, and patient confidentiality was maintained throughout the research process in accordance with the Declaration of Helsinki. Patients with large tympanic membrane perforations and with comorbid conditions such as diabetes, bronchial asthma, chronic obstructive pulmonary disease (COPD), or allergic rhinitis were excluded to control for potential confounding factors.

The PRF was prepared from each patient's autologous blood. At first 10ml venous blood samples were collected in plain tubes and centrifuged at 4000 revolutions per minute (rpm) for 10 minutes at room temparature. This centrifugation process yielded a PRF clot which was molded into a sheet suitable for application on the TM. Before PRF application, the perforation margins were refreshed by removing fibrotic tissue under local anesthetic spray to stimulate the healing process. Under endoscopic guidance, PRF sheets were applied over the perforated TM with the aid of an Endoholder, ensuring precise placement. Patients were instructed to keep their head upright for a minimum of 24 hours post-procedure to support PRF adhesion.

Data collection was conducted using a standardized data collection sheet developed specifically for this study. Baseline data were collected on patient demographics, medical history, and relevant clinical characteristics. Hearing function was assessed pre-procedurally using Pure Tone Audiometry (PTA), which measured hearing loss between 20–40 dB and air-bone (A-B) gap averaging 5–30 dB across the study group. The Weber test was lateralized to the affected ear in all patients, and Rinne's test results were bone conduction (BC) greater than air conduction (AC) for all pre-procedural patients. Additional assessments included: Visual Analog Score (VAS) for pain, rated from 0 to 10; Speech Discrimination Scores (SDS), with baseline scores ranging from 70 to 100; Hearing Handicap Inventory for Adults (HHIA) to evaluate quality of life impacts, with scores ranging from 10 to 20. Patients were followed up one-month post-procedure, with assessments including otoscopic examination, PTA, tuning fork tests, VAS for pain, SDS, and HHIA.

Data were analyzed using statistical software SPSS version 20.0. Descriptive statistics were used to summarize demographic characteristics, pre-and post-treatment PTA results, VAS, HHIA, and SDS scores. For quantitative outcomes such as hearing improvement (in dB), paired sample t-tests were applied to assess differences between pre- and post-treatment scores. Statistical significance was set at $p < 0.05$. Satisfaction scores and categorical data were summarized as frequencies and percentages, with chi-square tests used to analyze associations between demographic characteristics and clinical outcomes. The ethical review board of Sir Salimullah Medical College Mitford Hospital approved the study protocol.

Results:

The study included 35 patients with small, single-sided central tympanic membrane (TM) perforations, with a mean age of 37.7 years (SD=15.4), ranging from 15 to 65 years. Among them, 20 (57.1%) were female, and the majority (77.1%) identified as Muslim, with 22.9% Hindu and 2.9% Christian participants. Baseline audiological assessments showed PTA hearing loss between 20 to 40 dB, with an average air-bone (A-B) gap of 15.4 dB (SD=7.3). The Weber test was lateralized to the affected ear in all cases, while Rinne's test indicated BC > AC pre-procedurally. Speech Discrimination Scores (SDS) averaged 85.6% (SD=10.5), ranging from 70% to 100%, and Hearing Handicap Inventory for Adults (HHIA) scores ranged from 10 to 20, with a mean of 14.3 (SD=3.2), indicating mild to moderate hearing handicap. At the one-month follow-up, otoscopic examination confirmed a 94.3% success rate, with complete TM healing in 33 of 35 cases. PTA in healed cases improved significantly from 27.6 dB (SD=6.9) to 12.3 dB (SD=4.6), with a mean improvement of 15.3 dB (SD=6.3) ($p < 0.001$). The A-B gap reduced from 15.4 dB (SD=7.3) to 3.2 dB (SD=1.8) ($p < 0.001$). Post-procedure, 33 patients showed central Weber results and AC > BC in Rinne's test, confirming conductive hearing improvement, while the two patients without healing showed no change. SDS improved significantly from 85.6% (SD = 10.5) to 95.3% (SD=5.1) ($p < 0.01$), and HHIA scores in the healed cases improved from 14.3 (SD = 3.2) to 1.8 (SD=1.2) ($p < 0.001$), indicating a substantial quality-of-life improvement, while the two unsuccessful cases remained unchanged. All patients reported a VAS pain score of 0 pre- and post-procedure, with high satisfaction scores ranging from 20 to 30 out of 30 (mean=28.2, SD=2.1). Even in non-healed cases, satisfaction remained high (mean=25.5) (Table-I). None of the patients had prior knowledge of PRF or the Endoholder technique, but all expressed satisfaction with its minimally invasive, quick, and cost-effective nature.

The study demonstrated significant improvements in hearing function, quality of life, and patient satisfaction following the application of PRF to small central TM perforations. The high success rate (94.3%) and statistically significant improvements across multiple outcome measures ($p < 0.001$) underscore the therapeutic potential of PRF in TM perforation healing.

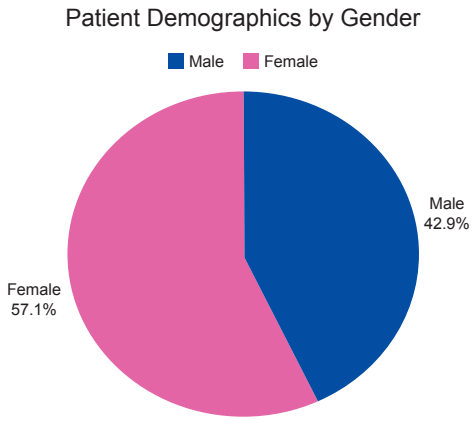

Figure 1: Distribution of patients according to gender.

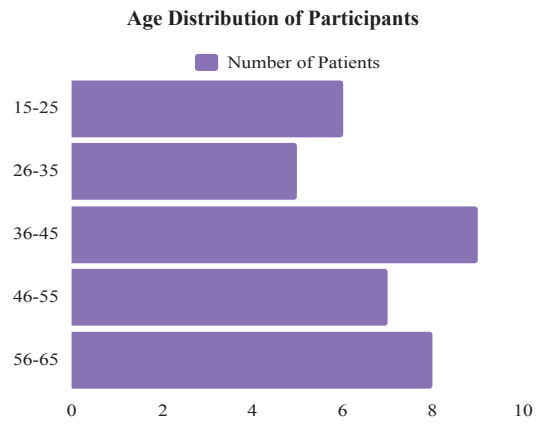

Figure 2: Distribution of patients according to age.

Table I: Distribution of patients according to summary of Key Findings (Mean, SD, p-values) (N=35)

Variable	Pre-Procedure Mean (SD)	Post-Procedure Mean (SD)	p-value
Hearing Threshold (dB)	32.3 (6.5)	17.0 (5.2)	<0.001
Air-Bone Gap (dB)	15.4 (7.3)	3.2 (1.8)	<0.001
Speech Discrimination Score (%)	85.6 (10.5)	95.3 (5.1)	<0.001
HHIA Score	14.3 (3.2)	1.8 (1.2)	<0.001
Patient Satisfaction (Score/30)	28.2 (2.1)		

Discussion:

This study aimed to assess the efficacy of autologous Platelet-Rich Fibrin (PRF) in promoting the closure of small central TM perforations. Results demonstrated a significant improvement in hearing thresholds, a reduction in air-bone gaps, and enhanced speech discrimination scores among the majority of participants after treatment. With 94% of patients achieving successful TM closure, PRF has shown to be a promising alternative in otolaryngology, particularly for patients with persistent perforations where conventional myringoplasty may not be feasible. These outcomes align with the current body of literature on PRF's regenerative properties, supporting its role in wound healing and tissue repair across multiple medical domains. The high success rate observed in this study is consistent with findings by Shetty et al.[18] in reference who reported comparable efficacy of PRF in TM perforation healing, highlighting PRF's ability to enhance fibroblast proliferation and collagen deposition.[18]

PRF's regenerative potential in otolaryngology has been attributed to its concentration of growth factors, including platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), and vascular endothelial growth factor (VEGF), which collectively promote angiogenesis and cellular proliferation in tympanic tissues.[19] Comparatively, PRF's efficacy in TM healing demonstrates advantages over Platelet-Rich Plasma (PRP) approaches, which may require more frequent application to achieve similar outcomes due to faster growth factor release kinetics.[20] Notably, the air-bone gap reduction achieved in this study aligns with earlier research indicating that PRF can effectively restore conductive hearing in patients with traumatic TM perforations, particularly when applied in small perforations that involve less than one quadrant.[21]

The improvement in quality of life, as indicated by HHIA scores, is another critical outcome. Previous studies, such as those by Kumar et al.[22] emphasized the importance of functional hearing restoration in reducing the psychological burden associated with hearing impairment. Additionally, the enhancement in speech discrimination observed aligns with research by Choudhary et al.[23] which demonstrated that PRF not only improves anatomical integrity but also augments sound perception and clarity by facilitating superior TM healing.

In line with recent advancements in endoscopic ear surgery, the use of endoholders in this study provided minimally invasive PRF application. This technique, as noted by Ishikawa et al.[24], enhances precision in perforation repair and patient comfort, resulting in higher patient satisfaction and procedural acceptance. Notably, the findings align with those from functional endoscopic sinus surgery (FESS) applications, where PRF's tissue healing advantages have also been demonstrated.[25]

Despite the favorable results, limitations include the study's reliance on purposeful convenient sampling, which may introduce selection bias, and the absence of a control group for direct comparison, as suggested in studies by Rad et al.[26] Future research should explore randomized controlled trials with a larger sample size to further substantiate these findings. Additionally, comparing PRF with other regenerative agents, such as hyaluronic acid or collagen scaffolds, as examined by Chaudhary et al.[27] could provide insights into optimizing therapeutic protocols for TM perforation repair.

In conclusion, this study underscores the therapeutic potential of PRF for TM perforation closure, corroborating recent research on its regenerative capabilities and adding to the growing evidence supporting PRF's role in otologic surgeries. Further investigation into PRF's comparative efficacy, especially in varying TM perforation sizes and conditions, is recommended to expand its clinical application in otolaryngology.

Conclusion:

This study has several limitations that warrant consideration. The sample size was relatively small (n=35), which may limit the generalizability of the findings to larger populations. Additionally, the study lacked a control group, making it difficult to compare PRF efficacy directly against traditional tympanoplasty or other regenerative treatments. The follow-up period was limited to one month, preventing long-term assessment of TM integrity and hearing outcomes. Furthermore, subjective measures like patient satisfaction, may introduce bias, even though objective measures like audiometry were also utilized. Based on the findings of this study, several recommendations can be made for future research and clinical practice. First, larger-scale studies with randomized controlled trials are essential to strengthen the evidence on the efficacy of Platelet Rich Fibrin (PRF) in treating small tympanic membrane perforations, allowing for more robust statistical analysis and generalizability. Incorporating longer follow-up periods will help determine the durability of PRF treatment outcomes over time. Additionally, exploring varying concentrations of PRF and comparing its efficacy with other biomaterials may provide insights into optimizing treatment protocols in otologic practice.

Conflict of interest:

There is no conflict of interest.

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