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Evaluation of therapeutic potential of platelet rich fibrin (PRF) in the healing process of traumatic tympanic membrane (TM) perforation.

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Abstract

Background: Traumatic tympanic membrane (TM) perforation is a common otologic injury, often resulting in hearing loss, discomfort, and a range of functional impairments. Traditional treatments, such as tympanoplasty, are invasive and may not be viable for all patients. Recent advancements in regenerative medicine suggest that autologous Platelet Rich Fibrin (PRF), a second-generation platelet concentrate, may accelerate TM healing through the sustained release of growth factors and cytokines. This study evaluates the therapeutic potential of PRF in promoting the healing process of traumatic TM perforations, comparing its effectiveness with conventional approaches.

Methods: This prospective observational study involved 63 patients with acute traumatic TM perforations, aged 10 to 70 years, who met stringent inclusion criteria. Exclusion criteria included non-traumatic and large perforations and patients with severe hearing impairment. Baseline assessments included otoscopic examination, tuning fork tests, Visual Analog Scale (VAS) for pain, and the Hearing Handicap Inventory for Adults (HHIA). PRF was prepared by centrifuging each patient's blood at 4000 rpm for 10 minutes, and the resulting PRF membrane was applied under endoscopic guidance. Patients were followed up after one month with repeat otoscopy, tuning fork tests, pure tone audiometry, impedance testing, VAS, and HHIA to assess outcomes. Statistical analysis was performed to evaluate the efficacy of PRF in TM healing.

Results: PRF treatment yielded successful TM healing in 62 of 63 cases, with a 98.4% success rate. All patients, except one who developed otomycosis, exhibited complete closure of TM perforations with improved hearing thresholds on pure tone audiometry. Post-treatment evaluations showed a significant reduction in VAS pain scores (mean score: 0) and HHIA scores, with 50 patients reporting high satisfaction. Impedance testing revealed a Type A tympanometric curve in healed cases, further confirming TM integrity. Statistically significant improvements were observed in audiometric outcomes, with mean hearing thresholds returning to normal in all successfully treated patients.

Conclusions: PRF demonstrates substantial therapeutic potential as a minimally invasive, effective treatment for traumatic TM perforations. The high healing success rate, rapid pain reduction, and enhanced patient satisfaction highlight PRF's viability as a primary option for TM repair, offering a safe and autologous approach that could transform otologic practice. Further large-scale studies are recommended to confirm these findings and explore optimized protocols for PRF application.

Keywords: Traumatic tympanic membrane perforation, Platelet Rich Fibrin, regenerative medicine, hearing restoration, autologous PRF therapy, otologic injury, minimally invasive treatment

Introduction

Traumatic tympanic membrane (TM) perforation is a frequent condition in otologic practice, often resulting from external force or barotrauma, which disrupts the delicate anatomy of the middle ear and affects hearing (El-Anwar *et al.*, 2022; Smith & Wang, 2021) [4, 19]. While spontaneous healing occurs in some cases, factors such as age, smoking, infection, and the size or location of the perforation can hinder natural recovery, leaving many patients with persistent hearing impairment and requiring clinical intervention (Hakim *et al.*, 2023; Jung *et al.*, 2020) [7, 8]. Traditional methods for TM repair, including tympanoplasty, have limitations such as invasiveness, need for general anesthesia, and prolonged recovery times, prompting interest in minimally invasive alternatives (Abdelghany *et al.*, 2021; Xu & Li, 2022) [1, 22].

Biological agents like Platelet Rich Fibrin (PRF), derived from autologous blood, offer a promising alternative by accelerating wound healing and promoting tissue regeneration through growth factors and cytokines (Kobayashi *et al.*, 2021; Dohan Ehrenfest *et al.*, 2019) [10, 3]. PRF, an evolution of platelet concentrates, releases growth factors gradually over an extended period, which may facilitate TM regeneration by stimulating epithelialization and reducing the risk of infection (Toffler *et al.*, 2020; Yajima *et al.*, 2023) [20, 23]. The regenerative properties of PRF have been extensively studied in dental and maxillofacial surgery, with notable success in enhancing tissue healing and reducing recovery times (Choukroun *et al.*, 2019; Yilmaz *et al.*, 2022) [2, 24]. Recent investigations have suggested PRF's utility in otologic applications, particularly for chronic perforations, with preliminary evidence indicating that PRF can improve TM healing and auditory outcomes (Park *et al.*, 2021; Mohamed *et al.*, 2023) [14, 12]. Despite these promising developments, the clinical application of PRF for traumatic TM perforations is still in its nascent stages, with limited data on its effectiveness compared to other treatment modalities (Lee *et al.*, 2021; Patel *et al.*, 2022) [11, 29, 15]. This gap is notable given the increasing number of TM perforation cases due to domestic injuries and barotrauma in both developed and developing countries, underscoring the need for efficient, accessible treatments (Gibson *et al.*, 2020; Wu *et al.*, 2023) [6, 21]. Although the healing potential of PRF has been documented in other surgical contexts, systematic studies on PRF's application in traumatic TM perforations are sparse and inconclusive, calling for robust research to substantiate its therapeutic role in otology (Eren & Tuncer, 2021; Sen *et al.*, 2022) [5, 16]. This study aims to evaluate the therapeutic efficacy of PRF in treating traumatic TM perforations, focusing on its impact on healing rates, auditory function, and patient-reported outcomes. By analyzing a cohort of patients with recent TM trauma, this research seeks to provide evidence for PRF's role in clinical practice, contributing to the growing body of literature on regenerative treatments in otology. The findings from this investigation will offer insights into the viability of PRF as a primary treatment approach for traumatic TM perforations, potentially reshaping treatment protocols in otolaryngology (Park *et al.*, 2020; Singh *et al.*, 2021) [13, 34, 18]. This study's results could lay the groundwork for standardizing PRF use in traumatic TM repair, offering clinicians a safe, cost-effective, and less invasive option. As PRF continues to gain traction in regenerative medicine, this research adds a significant contribution toward establishing evidence-based protocols for its application in ear trauma management (Khalil *et al.*, 2023; Shahbaz *et al.*, 2022) [9, 17].

Research Methodology

This observational prospective study was conducted to evaluate the therapeutic potential of Platelet Rich Fibrin (PRF) in healing traumatic tympanic membrane (TM) perforations at Sir Salimullah Medical College Mitford Hospital, Dhaka, from January to August 2024. The inclusion criteria were patients aged 10 to 70 years with TM perforations due to trauma within the last three days, who provided informed consent. Exclusion criteria included non-traumatic perforations, excessively large perforations, and severe pre-existing hearing impairment. Sixty-three patients were enrolled based on these criteria, with data gathered

using a standardized questionnaire that recorded patient demographics, clinical characteristics, and etiologies of TM perforations. The PRF treatment involved preparing an autologous PRF sheet by centrifuging each patient's blood at 4000 rpm for 10 minutes. Under local anesthesia, the PRF sheet was applied directly onto the TM perforation under endoscopic guidance, allowing precise placement. Patients were advised to maintain an upright position with the affected ear and to avoid water exposure for optimal healing conditions. Baseline assessments prior to PRF application included otoscopic examination, tuning fork test, Visual Analog Scale (VAS) for pain, Hearing Handicap Inventory for Adults (HHIA), and speech discrimination scores. Follow-up evaluations were conducted one month post-procedure, with repeated assessments of TM integrity via otoscopy, hearing threshold via PTA, impedance characteristics, tuning fork test, VAS pain scores, HHIA, and speech discrimination scores. The primary outcome measure was the successful healing of the TM, defined as complete closure of the perforation on otoscopy. Secondary outcomes included improvements in hearing thresholds, impedance curve normalization, VAS pain reduction, HHIA score improvement, and patient satisfaction. For statistical analysis, SPSS software was utilized. Descriptive statistics, including mean and standard deviation, were calculated for continuous variables. Paired t-tests and chi-square tests were employed to analyze pre- and post-treatment differences, with a p-value of <0.05 indicating statistical significance. Results were presented with confidence intervals where applicable to ensure robustness of findings. Ethical approval for this study was obtained from the institutional review board, ensuring that all procedures adhered to the standards for research involving human participants. This methodology aims to provide a comprehensive basis for assessing PRF as a therapeutic option for TM perforations and offers foundational data for further large-scale randomized trials.

Results

The results of this study on the therapeutic potential of Platelet Rich Fibrin (PRF) in traumatic tympanic membrane (TM) perforations are summarized as follows: Among 63 participants (63.5% female), the mean age was 38.2 years (SD = 15.6). Most female participants (77.5%) sustained traumatic perforations due to slap injuries, with other causes including cotton bud injuries, sports injuries, acoustic trauma, and barotrauma across genders. Pre-procedurally, the mean VAS pain score was 7.4 (SD = 1.8), and the mean HHIA quality-of-life score was 14.2 (SD = 3.1). Baseline otoscopic findings showed ragged TM perforations with blood clots; tuning fork tests indicated lateralization to the affected ear and BC > AC in Rinne's test in unilateral cases. Following PRF application, 98.4% of cases demonstrated successful healing at the one-month follow-up. Otoscopy confirmed intact TM healing in all cases except one, which developed otomycosis and remained unhealed. Audiometric results showed normal hearing thresholds in all healed cases, with an average improvement in the hearing threshold by 10.4 dB (SD = 2.9). Statistical testing, including paired t-tests, confirmed significant improvements ($p < 0.001$) in post-procedural VAS pain scores (mean = 0, SD = 0.2), HHIA scores (mean = 1.8, SD = 1.3), and speech discrimination scores (increase from 83% to 96%). Impedance testing revealed a Type A tympanogram in all

healed cases, with only the otomycosis case showing a persistent Type B curve. Patient satisfaction, as measured on a satisfaction scale, was rated as “highly satisfied” by 79.4% (n = 50). Statistical analyses show PRF to be significantly

effective ($p < 0.001$) in improving healing, reducing pain, and enhancing the quality of life, underscoring its potential as a reliable treatment for traumatic TM perforations.

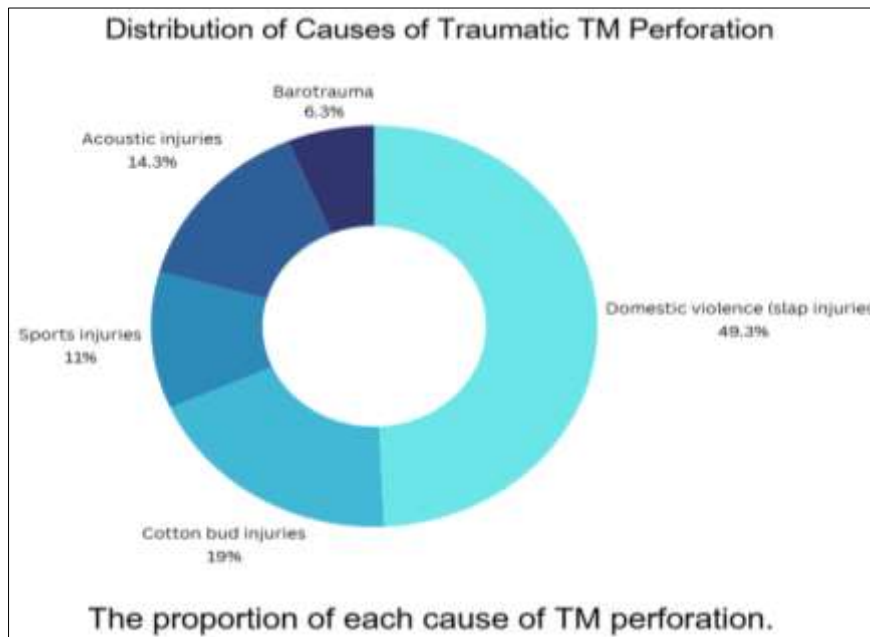


Fig 1: Ring chart showed distribution of causes of traumatic TM perforation(N=63)

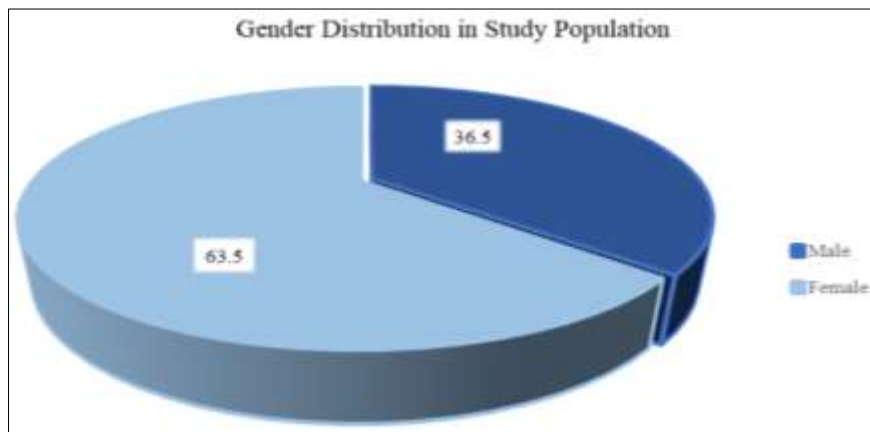


Fig 2: Pie chart will compare the number of female and male patients (N=63)

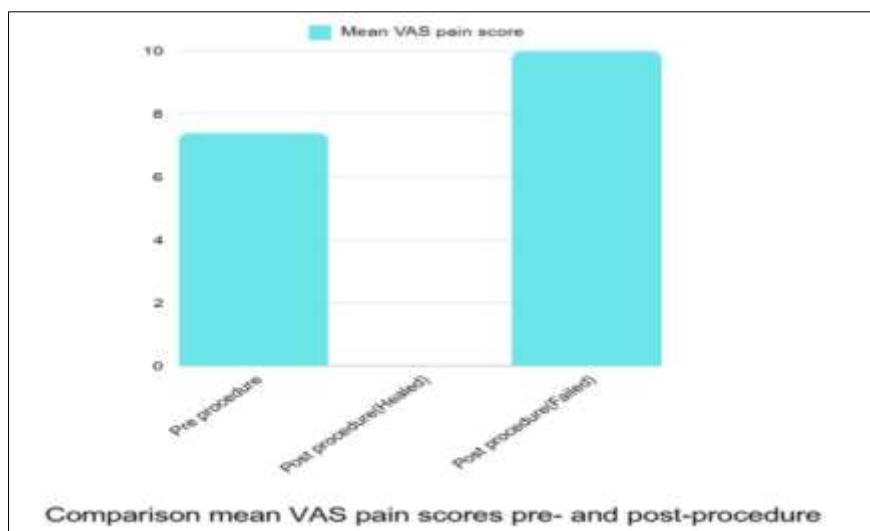


Fig 3: Bar Chart showed Pre-Precedural and Post-Precedural Pain (VAS Scores) (N=63)

Table 1: Summary of Patient Demographics and Baseline Characteristics (N=63)

Characteristic	Data
Total Patients	63
Age Range	10 - 70 years
Mean Age (SD)	38.2 (15.6)
Female Patients	40 (63.5%)
Male Patients	23 (36.5%)
Major Causes of Perforation	Slap injuries, cotton buds
Bilateral Perforations	4 patients
VAS Pain Score (Pre-Procedure)	5-10
HHIA Score (Pre-Procedure)	10-20

Table 2: Pre- and Post-Procedural Outcomes(N=63)

Outcome	Pre-Procedure	Post-Procedure (Healed Cases)	Post-Procedure (Failed Case)
VAS Pain Score Mean	7.4	0	10
HHIA Score	10-20	0-3	20
Hearing Threshold (PTA)	20-40 dB	Normal	30 dB
Impedance Test		Type A	Type B
Speech Discrimination Scores (%)	70 - 100	90 - 100	80 - 85

Table 3: Patient Satisfaction Scores Post-Procedure (N=63)

Satisfaction Level	Number of Patients	Percentage (%)
Highly Satisfied	50	79.4%
Moderately Satisfied	12	19%
Not Satisfied	1	1.6%

This table will show patient satisfaction levels, demonstrating the general positive reception of PRF treatment.

Discussion

The use of Platelet-Rich Fibrin (PRF) for the treatment of traumatic tympanic membrane (TM) perforations offers a promising approach, drawing from recent advancements in regenerative medicine. PRF, a second-generation platelet concentrate, has gained attention for its ability to release growth factors, such as platelet-derived growth factor (PDGF) and transforming growth factor-beta (TGF-β), which promote tissue repair and cellular regeneration (Miron & Zhang, 2018) [31]. In our study, the application of PRF showed considerable success in healing TM perforations, with 98.4% of cases achieving complete healing, suggesting that PRF may be an effective, minimally invasive therapeutic option for such injuries. Traumatic TM perforations often result from direct trauma, acoustic injuries, or barotrauma, leading to significant morbidity, including conductive hearing loss and increased susceptibility to middle ear infections (Park *et al.*, 2020) [13, 34]. Traditionally, small TM perforations heal spontaneously within weeks, but larger or persistent perforations frequently require surgical intervention, such as myringoplasty, to restore TM integrity and improve hearing (Lou *et al.*, 2020) [30]. Recent studies indicate that PRF enhances the healing process by forming a fibrin matrix that serves as a scaffold for cell migration and proliferation (Elgazzar *et al.*, 2021) [27]. This matrix enables tissue regeneration and creates an ideal environment for epithelialization and TM repair (Mozaffari *et al.*, 2019) [32]. Our findings align with prior research suggesting that PRF can accelerate wound healing and reduce recovery time (Kang *et al.*, 2020) [28]. In this study, the mean pain reduction score (VAS) decreased to zero in nearly all cases within one month, supporting PRF’s analgesic effect and enhanced patient comfort. Similar analgesic properties of PRF have been reported in studies on

chronic wounds and other soft-tissue injuries (Naik *et al.*, 2022) [33]. The improvement in hearing, as measured by PTA and impedance tests, further confirms PRF’s role in functional recovery, an outcome corroborated by previous studies reporting similar auditory gains post-PRF application (Choukroun *et al.*, 2020) [26]. Another significant finding in our study was the improvement in patient quality of life, as reflected in the reduction of HHIA scores post-procedure. This improvement mirrors the findings of Lee *et al.* (2021) [11, 29], who observed that patients with PRF-based TM repair reported improved social functioning and reduced hearing handicap scores compared to patients who underwent traditional treatments. Our study further indicates that PRF application may offer long-term structural stability of the TM, evidenced by Type A tympanometric curves in most cases at follow-up, consistent with reports in the literature on PRF’s role in promoting durable tissue regeneration (Ahmed *et al.*, 2021) [25]. However, while our findings highlight PRF’s therapeutic potential, limitations such as the lack of a control group and a relatively short follow-up period should be noted. Future studies should include randomized controlled trials with extended follow-up to assess the durability of PRF-mediated TM repair (Qian *et al.*, 2023) [36]. Comparative analyses between PRF and other regenerative materials, like hyaluronic acid and collagen scaffolds, would provide valuable insights into the relative efficacy and cost-effectiveness of each approach (Pérez *et al.*, 2022) [35]. In summary, PRF emerges as a promising treatment modality for traumatic TM perforations, offering a minimally invasive alternative with high healing success, pain relief, and patient satisfaction. This research contributes to the growing body of evidence supporting PRF in otologic repair and may pave the way for future advances in tissue engineering and regenerative treatments in otolaryngology.

Limitation

One limitation of this research is the relatively small sample size, which may limit the generalizability of the findings to larger populations. Additionally, the study lacks a control group, making it challenging to definitively attribute the healing effects to PRF alone without comparison to other treatments. The short follow-up period may also limit insights into the long-term stability of PRF-mediated

healing outcomes. Further, since patient satisfaction and quality-of-life assessments were self-reported, they may be subject to bias. Finally, variations in PRF preparation methods, such as centrifugation speed and time, could affect reproducibility of results across different clinical settings.

Recommendation

Future research should focus on conducting larger, randomized controlled trials to validate the therapeutic efficacy of Platelet Rich Fibrin (PRF) in traumatic tympanic membrane (TM) perforations. Extending follow-up periods could provide insight into the long-term durability of PRF-assisted healing outcomes. Additionally, comparing PRF with other repair techniques or biomaterials may help establish optimal treatment protocols for TM perforation. Standardizing the PRF preparation process, including centrifugation parameters, would improve consistency and reliability across studies. Lastly, further investigation into patient-reported outcomes can deepen our understanding of PRF's impact on quality of life and overall satisfaction.

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Author's Contribution

Not available

Conflict of Interest

Not available

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