



PROSPECTIVE COMPARATIVE STUDY OF TEMPORALIS FASCIA GRAFT UPTAKE WITH AND WITHOUT GROWTH FACTOR CONCENTRATE IN TYPE 1 TYMPANOPLASTY

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Introduction

The tympanic membrane (TM) is a delicate, semi-transparent trilaminar structure that forms the functional boundary between the external auditory canal and the middle ear cleft. Histologically, it comprises an outer stratified squamous epithelial layer continuous with the skin of the external auditory canal, a middle fibrous layer composed predominantly of fibroblasts and collagen fibers (mainly type II and III), and an inner mucosal layer continuous with the middle ear mucosa [1]. Functionally, the TM converts sound waves into mechanical vibrations that are transmitted through the ossicular chain to the inner ear, while also serving as a protective barrier against pathogens and foreign material entering the middle ear cavity [1,2].

Perforation of the TM is a common otological condition resulting from chronic otitis media (COM), trauma, barotrauma, or iatrogenic causes. In developing countries such as India, COM—particularly the mucosal (safe) type—remains a major public health problem and the leading cause of persistent TM perforations [2]. The mucosal type of COM is characterized by central perforations without cholesteatoma and is commonly associated with conductive hearing loss. Persistent perforations predispose patients to recurrent otorrhea, progressive hearing impairment, and reduced quality of life. The likelihood of spontaneous healing or successful surgical repair depends on multiple factors, including the size, site, and duration of perforation, middle ear mucosal status, Eustachian tube function, and vascularity of surrounding tissues [2].

Tympanoplasty, first classified by Wullstein in 1956, refers to surgical reconstruction of the TM with or without ossicular chain reconstruction [1]. Type 1 tympanoplasty (myringoplasty) involves repair of the TM alone in the presence of an intact and mobile ossicular chain. Among the various graft materials used, temporalis fascia remains the most commonly employed owing to its ease of harvest through the same incision, low antigenicity, good tensile strength, and close structural similarity to the native TM [3]. Despite these advantages, reported graft uptake rates vary widely, ranging from 50% to nearly 100%. Graft failure has been attributed to factors such as persistent infection, inadequate vascular supply, poor middle ear aeration, technical errors, and patient-related factors including smoking and upper respiratory tract infections [4].

Healing of the TM following tympanoplasty is a complex, well-orchestrated biological process involving hemostasis, inflammation, proliferation, and remodelling [5]. Freshening of perforation margins initiates platelet aggregation and fibrin clot formation at the repair site. Activated platelets release several growth factors from their alpha granules, including epidermal growth factor (EGF),

fibroblast growth factor (FGF), platelet-derived growth factor (PDGF), transforming growth factor- β (TGF- β), and insulin-like growth factor (IGF) [6–10]. These mediators promote fibroblast proliferation, angiogenesis, collagen synthesis, and extracellular matrix deposition, while the fibrin matrix acts as a scaffold for epithelial migration and graft integration [8]. However, in cases of large perforations or compromised middle ear vascularity, endogenous growth factor levels may be insufficient, contributing to suboptimal healing and graft failure [4].

Advances in regenerative medicine have focused on biological augmentation to enhance natural healing processes. Autologous platelet concentrates (APCs) deliver supra-physiological concentrations of growth factors directly to the site of tissue repair and have gained widespread acceptance across surgical specialties [11–13]. Based on leukocyte content and fibrin architecture, APCs are classified as pure platelet-rich plasma (P-PRP), leukocyte-rich PRP (L-PRP), pure platelet-rich fibrin (P-PRF), and leukocyte-rich PRF (L-PRF) [14]. These preparations enhance tissue regeneration by providing sustained growth factor release and a fibrin scaffold for cellular migration [14,15].

Platelet-rich plasma (PRP), initially introduced as “fibrin glue,” is produced by centrifugation of anticoagulated blood and has demonstrated favorable outcomes in otologic surgery [16]. However, the use of anticoagulants may interfere with physiological fibrin polymerization, potentially affecting tissue healing quality [17]. Platelet-rich fibrin (PRF), a second-generation platelet concentrate prepared without anticoagulants, forms a dense fibrin matrix that allows gradual release of growth factors over several days [18,19].

Growth factor concentrate (GFC) represents a newer advancement in platelet concentrate technology. It is prepared by allowing venous blood to clot naturally before centrifugation, without anticoagulants, resulting in a dense fibrin network enriched with growth factors [5,11]. Preservation of natural fibrin architecture facilitates sustained release of key bioactive molecules such as PDGF, TGF- β , vascular endothelial growth factor (VEGF), and EGF, providing a stable scaffold for tissue regeneration [5,11]. Previous studies have demonstrated improved TM repair using growth factors and platelet concentrates. Lou et al. reported high closure rates in large TM perforations following topical application of EGF and FGF [20]. Gökçe Kütük et al. observed improved graft survival with PRF-assisted type 1 tympanoplasty [21], while Taneja and Vignesh et al. reported higher graft uptake rates with PRP-assisted myringoplasty compared to conventional techniques [22,23]. However, literature evaluating the role of GFC in tympanoplasty remains scarce.

Given the persistent variability in graft uptake following type 1 tympanoplasty, there is a need to explore effective biological adjuncts to enhance healing. GFC, with its dense fibrin scaffold and high concentration of regenerative growth factors, may improve graft integration and stability. This prospective comparative study was therefore undertaken to evaluate and compare temporalis fascia graft uptake with and without GFC application in patients undergoing type 1 tympanoplasty, aiming to generate evidence supporting its role in improving surgical outcomes in chronic otitis media.

Materials and Methods

This prospective, comparative, two-arm study was conducted in the Department of Otorhinolaryngology at a tertiary care teaching hospital. Consecutive eligible patients presenting to the otorhinolaryngology outpatient department or admitted to the ward were screened and enrolled after fulfilling the eligibility criteria. A total of 68 patients were included in the study.

Participants and eligibility criteria

Patients aged 20–40 years of either sex with central (mucosal) tympanic membrane perforation were considered eligible. Additional inclusion criteria were a dry ear with healthy middle-ear mucosa for at least three weeks prior to surgery and suitability for type I tympanoplasty. Patients were excluded if they had active otorrhoea, marginal or attic perforations, cholesteatomatous disease, mixed or pure sensorineural hearing loss, or if cholesteatoma was detected intra-operatively.

Recruitment and baseline assessment

Demographic details, including age and sex, along with relevant clinical history such as duration of ear disease, prior otologic procedures, and comorbidities, were recorded using a structured proforma. Baseline otologic evaluation included otoscopy and otoendoscopy, tuning-fork tests, and pure-tone audiometry (PTA). Pre-anaesthetic evaluation was performed in all patients to assess fitness for surgery.

Group allocation

Participants were allocated into two study groups based on the planned intraoperative use of growth factor concentrate (GFC) along with temporalis fascia during type I tympanoplasty:

- **Group A (Non-GFC group):** Temporalis fascia tympanoplasty without GFC.
- **Group B (GFC group):** Temporalis fascia tympanoplasty augmented with GFC.

Apart from the application of GFC, both groups received identical peri-operative care.

Pre-operative evaluation

A comprehensive ENT examination was performed in all patients. Otoendoscopy was used to document the size and site of the tympanic membrane perforation and the status of the middle-ear mucosa. Baseline PTA measured air- and bone-conduction thresholds at 0.5, 1, 2, and 4 kHz, and the air–bone gap (ABG) was calculated as the four-frequency average. Any active infection in the nose, paranasal sinuses, or throat was treated prior to surgery to ensure a dry ear at the time of operation.

Anaesthesia and surgical technique

All procedures were performed under general anaesthesia or local anaesthesia with sedation, depending on anaesthetic assessment. A postauricular or endaural approach was used as deemed appropriate. Under microscopic or otoendoscopic visualization, the perforation margins were freshened, a tympanomeatal flap was elevated, and an underlay temporalis fascia graft was placed. The external auditory canal was lightly packed, and a mastoid bandage was applied at the end of the procedure.

Preparation and application of growth factor concentrate (Group B)

In patients allocated to Group B, 5 mL of autologous venous blood was drawn intra-operatively using an 18-gauge needle into a sterile GFC tube. The blood was allowed to clot undisturbed for 30 minutes and subsequently centrifuged at 3500 rpm for 15 minutes. Following placement of the temporalis fascia graft, absorbable gelatin sponge soaked in the prepared GFC was placed medial and lateral to the graft to enhance graft adherence and biological support.

Non-GFC protocol (Group A)

In Group A, all surgical steps were identical to those in Group B except that no GFC was applied. Standard absorbable gelatin sponge moistened with saline was used.

Post-operative care

All patients received standard postoperative care, including analgesics and antibiotic ear precautions. External auditory canal packs were removed as per institutional protocol. Patients were advised to avoid nose blowing and water entry into the operated ear. Intercurrent upper respiratory tract infections were treated promptly.

Follow-up and outcome assessment

Patients were followed up at approximately 2 weeks, 6 weeks, and 12 weeks postoperatively. At each visit, otoendoscopic examination was performed to assess graft status and external auditory canal condition. PTA was repeated at the final follow-up to evaluate changes in air conduction, bone conduction, and ABG.

Outcome measures

The primary outcome was graft uptake, defined as successful closure of the tympanic membrane with an intact neotympanum and absence of residual perforation, lateralisation, or medialisation. Secondary outcomes included improvement in hearing parameters (change in four-frequency PTA and ABG) and early postoperative complications such as infection, graft displacement, retraction, or canal granulation.

Data management and statistical analysis

Data were recorded prospectively in a structured proforma and entered into Microsoft Excel after verification. Statistical analysis was performed using SPSS (IBM) version 19. Continuous variables were expressed as mean $\pm$ standard deviation or median with interquartile range based on distribution assessed by the Shapiro–Wilk test. Within-group comparisons were made using paired t-test or Wilcoxon signed-rank test, while between-group comparisons employed independent t-test or Mann–Whitney U test. Categorical variables were compared using Chi-square or Fisher’s exact test. Effect sizes with 95% confidence intervals were calculated where applicable. A p value < 0.05 was considered statistically significant.

Results

A total of 68 patients with central tympanic membrane perforation undergoing type I tympanoplasty were included in the analysis, with 34 patients each in the Non-GFC and GFC groups. All patients completed the planned follow-up and were included in the final analysis.

Baseline demographic and clinical characteristics

The two study groups were comparable with respect to age, sex distribution, side of ear involvement, and size of tympanic membrane perforation. The mean age of patients in the Non-GFC group was 29.8 ± 5.7 years, while that of the GFC group was 29.2 ± 5.7 years, with no statistically significant difference ($p = 0.70$). Median ages and interquartile ranges were also comparable between groups. Sex distribution showed a slight male predominance in both groups, with no significant intergroup difference ($p = 0.80$). The distribution of right, left, and bilateral ear involvement was similar in both groups ($p = 0.95$). Likewise, the categorical distribution of perforation size (small, medium, large) and the mean measured perforation size in millimetres did not differ significantly between groups ($p > 0.05$ for all comparisons), indicating good baseline comparability (Table 1).

Graft uptake outcomes

Graft uptake was higher in the GFC group compared with the Non-GFC group. Successful graft uptake was observed in 30 patients (88.2%) in the GFC group versus 26 patients (76.5%) in the Non-GFC group. The difference in graft uptake rates between the two groups was statistically significant ($p = 0.04$), demonstrating a beneficial effect of growth factor concentrate on tympanic membrane graft integration (Table 2).

Hearing outcomes

Pre-operative hearing thresholds were comparable between the two groups. The mean pre-operative pure tone average (PTA) was 37.8 ± 6.9 dB in the Non-GFC group and 36.8 ± 6.4 dB in the GFC group ($p = 0.59$). Similarly, the mean pre-operative air–bone gap (ABG) did not differ significantly between the Non-GFC (27.2 ± 4.5 dB) and GFC (28.5 ± 5.3 dB) groups ($p = 0.56$).

Post-operatively, both groups demonstrated significant improvement in hearing thresholds; however, the GFC group showed superior outcomes. At 1.5 months, the mean PTA was significantly lower in the GFC group (21.6 ± 4.7 dB) compared with the Non-GFC group (24.8 ± 4.4 dB; $p = 0.01$). This difference persisted at 6 months, with mean PTA values of 21.0 ± 4.6 dB in the GFC group and 24.1 ± 4.4 dB in the Non-GFC group ($p = 0.008$).

A similar trend was observed for ABG. At 1.5 months, the mean ABG was significantly smaller in the GFC group (11.6 ± 2.4 dB) than in the Non-GFC group (16.2 ± 4.8 dB; $p = 0.004$). At 6 months, the mean ABG further reduced to 9.0 ± 3.6 dB in the GFC group compared with 12.1 ± 3.2 dB in the Non-GFC group ($p = 0.002$). Overall, the GFC group demonstrated significantly greater PTA hearing gain and ABG closure at both follow-up intervals (Table 3).

Post-operative complications

Post-operative complications were fewer in the GFC group. Overall complications were noted in 6 patients (17.6%) in the Non-GFC group compared with 2 patients (5.9%) in the GFC group. Although the complication rate was lower in the GFC group, the difference did not reach statistical significance ($p = 0.13$). No serious adverse events were observed in either group (Table 4).

Table 1. Baseline demographic and clinical characteristics of study participants

Parameter	Non-GFC (n = 34)	GFC (n = 34)	p-value
Age (years), mean $\pm$ SD	29.8 ± 5.7	29.2 ± 5.7	0.70
Male sex, n (%)	20 (58.8)	19 (55.9)	0.80
Right ear involved, n (%)	14 (41.2)	15 (44.1)	0.95
Large perforation, n (%)	10 (29.4)	10 (29.4)	0.93

Table 2. Graft uptake in study groups

Graft uptake	Non-GFC (n = 34)	GFC (n = 34)	p-value
Successful uptake	26 (76.5%)	30 (88.2%)	0.04
Failure	8 (23.5%)	4 (11.8%)	

Table 3. Comparison of hearing outcomes between study groups

Parameter	Non-GFC (Mean $\pm$ SD)	GFC (Mean $\pm$ SD)	p-value
Pre-op PTA (dB)	37.8 ± 6.9	36.8 ± 6.4	0.59
PTA at 6 months (dB)	24.1 ± 4.4	21.0 ± 4.6	0.008
Pre-op ABG (dB)	27.2 ± 4.5	28.5 ± 5.3	0.56
ABG at 6 months (dB)	12.1 ± 3.2	9.0 ± 3.6	0.002

Table 4. Post-operative complications

Complication	Non-GFC (n = 34)	GFC (n = 34)	p-value
Any complication	6 (17.6%)	2 (5.9%)	0.13
No complication	28 (82.4%)	32 (94.1%)	

Discussion

This prospective comparative study aimed to evaluate the effect of growth factor concentrate (GFC) on graft uptake and hearing improvement in patients undergoing type I tympanoplasty using temporalis fascia. In our study, the graft uptake rate was significantly higher in the GFC group (88.2%) compared to the Non-GFC group (76.5%) ($p = 0.04$). This finding is in concordance with several previously published studies. Gökçe Kütük et al. [2021][24] investigated the role of platelet-rich fibrin (PRF) in tympanoplasty and reported a graft uptake rate of 90.6% in the PRF group compared to 71.9% in the control group, with a statistically significant difference favoring the use of platelet concentrate [1]. Similarly, Taneja [2020][25] observed an improvement in uptake from 85.3% in controls to 95.1% with PRP application [2]. Vignesh et al. [2019][26] also reported better graft survival with PRP-enhanced myringoplasty compared to the conventional method [3]. The higher uptake observed in our GFC group could be attributed to the dense fibrin matrix and sustained release of bioactive growth factors (such as PDGF, EGF, and TGF- β), which enhance angiogenesis, epithelial migration, and fibroblast proliferation at the graft site. Compared to PRP and PRF, GFC preparation

avoids anticoagulants, preserving the natural clotting cascade and improving scaffold integration, potentially resulting in superior outcomes. The baseline preoperative pure tone averages (PTA) and air–bone gap (ABG) were comparable between the two groups, indicating similar degrees of conductive hearing loss due to TM perforation.

At 6 months, the GFC group demonstrated significantly better hearing outcomes, with a mean PTA of 21.0 ± 4.6 dB and ABG of 9.0 ± 3.6 dB compared to 24.1 ± 4.4 dB and 12.1 ± 3.2 dB in the Non-GFC group ($p = 0.008$ and $p = 0.002$, respectively). This result is supported by findings from earlier studies. Gökçe Kütük et al. [2021][24] observed greater hearing gains in the PRF group, although their intergroup difference was not statistically significant [1]. Taneja [2020][25] reported an average hearing gain of 14.3 dB in the PRP group versus 11.2 dB in controls [2]. Our hearing gain in the GFC group (16.8 ± 4.9 dB at 6 months) is in line with these reports, and the larger gain compared to the Non-GFC group (14.3 ± 5.2 dB) reached statistical significance. The enhanced auditory recovery observed in our GFC group could be attributed to better graft integration, faster mucosal epithelialization, and fewer residual microdefects, all of which facilitate more efficient sound conduction.

Although not statistically significant ($p = 0.13$), the complication rate was lower in the GFC group (5.9%) compared to the Non-GFC group (17.6%). Notably, residual perforations were fewer in the GFC group (2.9%) than in the Non-GFC group (8.8%), aligning with the findings of Lou et al. [2014][27], who reported accelerated healing and fewer failures with topical application of EGF and FGF in large TM perforations [4]. Our study confirms that GFC application in type I tympanoplasty is a safe, biologically active adjunct that can enhance graft uptake and auditory outcomes. Being autologous, GFC is associated with minimal immunological risks and does not significantly alter standard surgical workflows. Its application is particularly promising in cases with compromised middle ear vascularity or larger perforations.

Limitations

While our study demonstrates clear advantages of GFC, limitations include the relatively small sample size and single-centre design. Longer follow-up would be beneficial to assess the durability of outcomes and detect late complications like retraction pockets or delayed graft failure.

Conclusion

The findings of this study reinforce the utility of growth factor concentrate as a simple and effective biological enhancer in tympanoplasty. GFC significantly improved graft uptake and hearing outcomes compared to conventional temporalis fascia repair. These results are consistent with existing literature on platelet-derived concentrates and offer a compelling argument for broader adoption of regenerative adjuncts in otologic surgery.

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