The Egyptian Journal of Otolaryngology

ORIGINAL ARTICLE Open Access

Effect of platelet-rich plasma on recurrence of sinonasal polyps after endoscopic sinus surgery: a randomized clinical trial

Alaa Mohamed Abd El Samiea[1], Ahmed Soliman Elkady[1], Ahmed Abdelrahman Ibrahim Elnagdy[1*] and Abdelhakim Foaad Ghallab[1]

Abstract

Background Chronic rhinosinusitis with nasal polyps (CRSwNP) is a persistent inflammatory condition that often requires surgical intervention. Despite advances in endoscopic sinus surgery (ESS), recurrence rates remain significant. Platelet-rich plasma (PRP), known for its regenerative properties, has been suggested to reduce inflammation and promote healing.

Methodology This prospective randomized controlled clinical trial was carried out on 40 patients which aims to evaluate the effectiveness of PRP in reducing the recurrence and healing of sinonasal polyps after functional endoscopic sinus surgery (FESS) after 6 months follow-up. Patients aged over 18 years and under 60 years old, with more than 3 months of CRS symptoms with endoscopic evidence of polyps and/or mucosal changes on a CT scan were included in our study. Previous sinus surgery, systemic vasculitis, immune deficiency, allergic fungal rhinosinusitis, patients with uncontrolled systemic diseases or coagulopathy, history of asthma, aspirin sensitivity, cystic fibrosis, and congenital mucociliary problems were excluded from our study.

Results Both groups showed improvement in Lund-Kennedy scores and SNOT-22 scores postoperatively. However, Group 1 demonstrated significantly greater improvement at 3 months (median Lund-Kennedy score: 4.0 vs. 6.0, $p < 0.001$) and 6 months (median Lund-Kennedy score: 4.5 vs. 6.0, $p < 0.001$) compared to Group 2. Additionally, the percent change in Lund-Kennedy scores was significantly higher in Group 1 (median 40.18% vs. 14.29%, $p < 0.001$). Group 1 also exhibited a substantial reduction in SNOT-22 scores at 6 months (median score: 7.0 vs. 45.0, $p < 0.001$) with a higher median percent change (90.91% vs. 43.65%, $p < 0.001$). Notably, relapse rates were lower in Group 1 (15.0%) compared to Group 2 (50.0%) at 6 months ($p = 0.018$).

Conclusions PRP injection during FESS significantly reduces the recurrence of sinonasal polyps and improves clinical outcomes in patients with CRSwNP. These findings suggest PRP as a promising adjunctive treatment to enhance surgical outcomes and reduce healthcare burdens associated with recurrent sinonasal polyposis.

Keywords Chronic rhinosinusitis, Nasal polyps, Endoscopic sinus surgery, Platelet-rich plasma, Lund-Kennedy score, SNOT-22

Background

Chronic rhinosinusitis with nasal polyps (CRSwNP) is a medical condition characterized by the thickening of the mucous membranes of the nose and paranasal sinuses that lasts for more than 3 months. Additionally, polyps can be seen during an endoscopic examination. Empirical

*Correspondence:
Ahmed Abdelrahman Ibrahim Elnagdy
ahmedabdoelnagdy@gmail.com
[1] Otolaryngology and Head & Neck Surgery Department, Faculty of Medicine, Benha University, Benha, Egypt

research has shown that individuals with CRSwNP experience a more significant load of chronic rhinosinusitis (CRS) symptoms and a higher likelihood of recurrence following either medication or surgical interventions [1].

The cause of CRSwNP is not fully understood. Nasal polyps can form due to several factors, including allergies, asthma, sensitivity to aspirin, fungal infections, and hereditary factors [2].

Currently, surgery is the primary and most effective method of treating nasal polyps that do not respond to conventional therapy. Endoscopic sinus surgery (ESS) is a procedure that restores the normal function of the nose and sinuses by improving the movement of mucus and allowing the administration of anti-inflammatory drugs directly to the operative area. Despite the high degree of satisfaction and overall reduction in symptoms with ESS, a significant proportion of patients (ranging from 23 to 87%) require revision surgery due to the return of polyps [3].

Platelets are small pieces of cytoplasm derived from megakaryocytes. These platelets produce seven essential protein growth factors which are important for wound healing such as platelet-derived growth factor (PDGF), transforming growth factor alpha (TGF-α), transforming growth factor beta (TGF-β), epidermal growth factor (EGF), fibroblast growth factor (FGF), insulin like growth factor and platelet-derived angiogenesis, all these factors help rapid wound healing, haemostasis and decrease scarring.

Platelet-rich plasma (PRP) is a type of blood that has a higher concentration of platelets than usual. This increased platelet count aids in the process of tissue repair and regeneration [4].

Multiple surgical specialties have recognized the potential benefits of platelet-rich concentrates. Their use has been described in ophthalmology, neurosurgery, general surgery, orthopedic, and sports medicine to relieve pain. Dermatologists have successfully used PRP for facial rejuvenation and for the treatment of various dermatological disorders.

Otolaryngologists have recently studied the role of PRP in tympanoplasty, cerebrospinal fluid rhinorrhea repair turbinoplasty, and ESS [4].

This study aims to evaluate the impact of PRP on the recurrence and healing of sinonasal polyposis following functional endoscopic sinus surgery (FESS).

Methods

This is a prospective randomized controlled clinical trial in which 40 patients were recruited from the ENT Outpatient Clinic, School of Medicine, Banha University, in the period from April 2023 till April 2024. All the patients had CRS with or without polyps with symptoms such as nasal obstruction, discharge, facial pain, and headache for at least 12 weeks. The diagnosis was settled by nasal endoscopy and computed tomographic (CT) scan of the nose and paranasal sinuses. The study was done after full ethical approval was granted by the Institutional Review Board of Banha University (MS 12–5-2023). A written informed consent was obtained from each participant.

Inclusion criteria

Patients aged over 18 years and under 60 years old, with more than 3 months of CRS symptoms with endoscopic evidence of polyps and/or mucosal changes on a CT scan, and who are candidates for FESS.

Exclusion criteria

Previous sinus surgery, systemic vasculitis, immune deficiency, allergic fungal rhinosinusitis, patients with uncontrolled systemic diseases or coagulopathy, history of asthma, aspirin sensitivity, cystic fibrosis, and congenital mucociliary problems.

Randomization and blindness

Patients were allocated randomly by a computer-generated sequence through sealed opaque envelopes into two equal categories. Both supervisor and the care-provider in this trial were blinded.

These patients were allocated into two equal groups. The first group included 20 patients with CRSwNP who underwent functional ESS with injection of PRP in the lateral nasal wall. The second group included 20 patients with CRSwNP who underwent only functional ESS.

Clinical evaluation

Following a thorough history and physical examination, fundamental clinical information was documented. The nasal cavity was inspected using a rigid nasal endoscope with both 0° and 30° angles. The endoscopic grade was determined using the Lund-Kennedy ratings (Fig. 1).

The 22-item Sino-Nasal Outcome Test (SNOT-22) questionnaire (Fig. 2) was used to evaluate the symptoms and health-related quality of life of the patients.

Characteristics	Nasal cavity	
	right	left
Polyp (0,1,2)		
Edema (0,1,2)		
Secretion (0,1,2)		
total		

Note: Polyp: 0 - absent; 1 - limited to the middle meatus; 2 - extending to the nasal cavity
Mucosa edema: 0- absent; 1- mild/moderate edema; 2- polypoid degeneration
Secretion: 0 absent; 1- hyaline; 2- thick and/or mucopurulent

Fig. 1 The Lund-Kennedy score of endoscopic assessment

I.D.:_____ **SINO-NASAL OUTCOME TEST (SNOT-22)** DATE:_____

Below you will find a list of symptoms and social/emotional consequences of your rhinosinusitis. We would like to know more about these problems and would appreciate your answering the following questions to the best of your ability. There are no right or wrong answers, and only you can provide us with this information. Please rate your problems as they have been over the past two weeks. Thank you for your participation. Do not hesitate to ask for assistance if necessary.

1. Considering how severe the problem is when you experience it and how often it happens, please rate each item below on how "bad" it is by circling the number that corresponds with how you feel using this scale: →	No Problem	Very Mild Problem	Mild or slight Problem	Moderate Problem	Severe Problem	Problem as bad as it can be		5 Most Important Items
1. Need to blow nose	0	1	2	3	4	5		○
2. Nasal Blockage	0	1	2	3	4	5		○
3. Sneezing	0	1	2	3	4	5		○
4. Runny nose	0	1	2	3	4	5		○
5. Cough	0	1	2	3	4	5		○
6. Post-nasal discharge	0	1	2	3	4	5		○
7. Thick nasal discharge	0	1	2	3	4	5		○
8. Ear fullness	0	1	2	3	4	5		○
9. Dizziness	0	1	2	3	4	5		○
10. Ear pain	0	1	2	3	4	5		○
11. Facial pain/pressure	0	1	2	3	4	5		○
12. Decreased Sense of Smell/Taste	0	1	2	3	4	5		○
13. Difficulty falling asleep	0	1	2	3	4	5		○
14. Wake up at night	0	1	2	3	4	5		○
15. Lack of a good night's sleep	0	1	2	3	4	5		○
16. Wake up tired	0	1	2	3	4	5		○
17. Fatigue	0	1	2	3	4	5		○
18. Reduced productivity	0	1	2	3	4	5		○
19. Reduced concentration	0	1	2	3	4	5		○
20. Frustrated/restless/irritable	0	1	2	3	4	5		○
21. Sad	0	1	2	3	4	5		○
22. Embarrassed	0	1	2	3	4	5		○

2. Please mark the most important items affecting your health (maximum of 5 items)_____ ↑

SNOT-22 Developed from modification of SNOT-20 by National Comparative Audit of Surgery for Nasal Polyposis and Rhinosinusitis Royal College of Surgeons of England.

Fig. 2 SNOT-22 questionnaire

Preparation

The patient was positioned on the operating table, facing the television display. The bed was inclined to situate the patient in reverse Trendelenburg. The patient's eyes were shielded with a transparent covering or partially obscured while ensuring that the surgeon had access to the middle area. The surgeon would periodically examine for any swelling that may indicate an orbital hematoma. At the beginning of the surgical procedure, a total of 20 ml of blood was extracted from the patient and transferred into tubes containing an anticoagulant called sodium citrate. These tubes were then subjected to processing using a laboratory centrifuge, as shown in Fig. 3. The blood was separated into its components using a centrifuge in two separate sessions. The initial phase, referred to as a gentle rotation, lasted

Fig. 3 Laboratory centrifuge

for 5 min at a speed of 2500 rpm, resulting in the separation of the blood into three distinct layers (Fig. 4). The middle layer, referred to as the PRP layer or "buffy coat," was moved to a separate tube without an anticoagulant and underwent a second centrifugation, known as a hard spin, at a speed of 3500 rpm for a duration of 10 min. The acellular plasma, which constituted 80% of the volume, was located in the uppermost part and was mostly extracted using a syringe and thereafter discarded. The residual 2–3 ml of plasma was utilized to disperse the platelet concentrate, as seen in Fig. 5.

Technique

The patients were administered hypotensive anesthesia in order to reduce bleeding to a minimum. 1:1000 adrenaline packs were administered, with pledgets inserted into the nasal cavity for a duration of 5 min before injecting locally into the mucosa. Following appropriate vasoconstriction, the middle turbinate was located, which serves as the primary reference point for the process. The uncinate process is located on the lateral wall of the nose, specifically near the anterior end of the middle turbinate. The removal of this revealed the ethmoid bulla and the hiatus semilunaris. The anterior ethmoid air cells were surgically accessed, resulting in improved air circulation while preserving the bone's mucosal covering. The maxillary ostium was examined and, if blocked, accessed with a middle meatal antrostomy. This little surgical procedure was frequently effective in significantly enhancing the functionality of the osteomeatal complex, hence resulting in improved airflow to the maxillary, ethmoid and frontal sinuses.

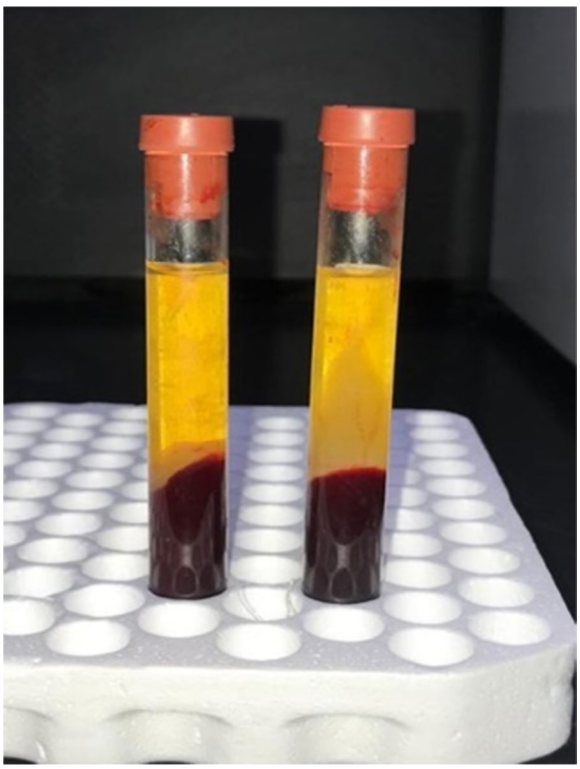

Fig. 4 Venous blood was centrifuged into 3 layers, the intermediate layer is PRP

Fig. 5 Pure PRP

When the preoperative CT scan revealed pathology in the posterior ethmoids and the sphenoid sinus, the decision to proceed with the full house FESS was made. In the first group, 3 ml of PRP was injected in the submucosa of lateral nasal wall specifically at lateral surface of middle turbinate, axilla of middle turbinate and ethmoidal cavity (Figs. 6 and 7).

Follow-up

All patients had postoperative nasal endoscopy and were graded using the Lund-Kennedy scores (Fig. 8), which were recorded at 4 weeks, 3 months, and 6 months. Polyp relapse was defined as the existence of polyps at 6 months, as assessed by endoscopic examination. The SNOT-22 scores were recorded during the 6-month appointment.

Sample size

The sample size calculation was performed using G.power 3.1.9.2 (Universitat Kiel, Germany). The sample size was calculated according to the overall Lund-Kennedy score of postoperative endoscopic assessment of nasal cavity after 1 month which was much higher in the PRP (study group) than that in the control group (1.28 ± 0.847 vs, 2.50 ± 0.877, $P < 0.001$) according to a previous study [5]. Based on the following considerations: 0.05 α error and 80% power of the study, allocation ration 1:1. Therefore, 40 patients were allocated.

Statistical analysis

The data were inputted into the computer and analysed using the IBM SPSS software programme version 20.0 (Armonk, NY: IBM Corp). Quantitative data were represented using numerical values and percentages. The Shapiro–Wilk test was employed to confirm the normality of the distribution. The quantitative data were characterized using several statistical measures, including the range (minimum and maximum values), mean, standard deviation, median, and interquartile range (IQR). The categorical variables were compared between various groups using the chi-square test. The Student's *t* test is used to compare two groups that have regularly distributed quantitative data. The Mann–Whitney test is used to compare two groups that have abnormally distributed quantitative data. The statistical significance of the acquired results was evaluated at a significance level of 5%.

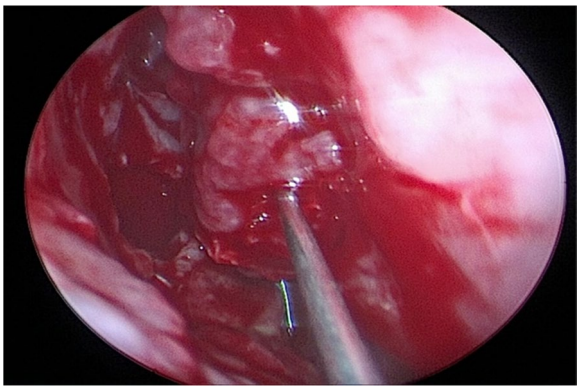

Fig. 7 Injection of PRP on middle turbinate

Results

In this study, 74 patients were assessed for eligibility, 23 patients did not meet the criteria and 11 patients refused to participate in the study. The remaining 40 patients were randomly allocated into two groups (20 patients in each). All allocated patients were followed up and analysed statistically (Fig. 9).

Table 1 presents a comparison between the two studied groups according to pre- and post-operative Lund-Kennedy scores. Group 1 consisted of CRSwNP

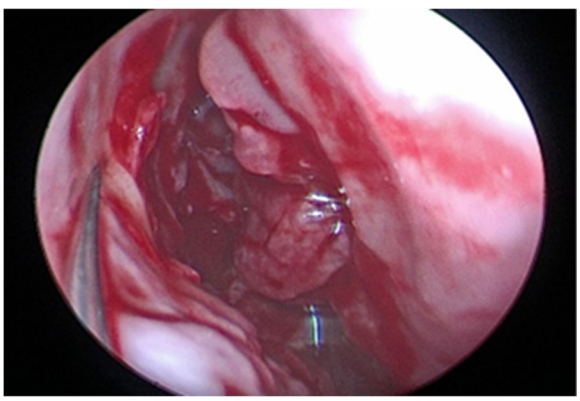

Fig. 6 Injection of PRP on lateral nasal wall

Lund-Mackay CT scan assessment
Paranasal sinuses
Maxillary (0, 1, 2)
Anterior ethmoid (0, 1, 2)
Posterior ethmoid (0, 1, 2)
Sphenoid (0, 1, 2)
Frontal (0, 1, 2)
Ostiomeatal complex (0, 2)*
Total
0 - With no abnormalities
1 - Partial opacification
2 - Total opacification

* 0: Without obstruction; 2: Obstructed.

Fig. 8 The Lund-Mackay CT scan assessment

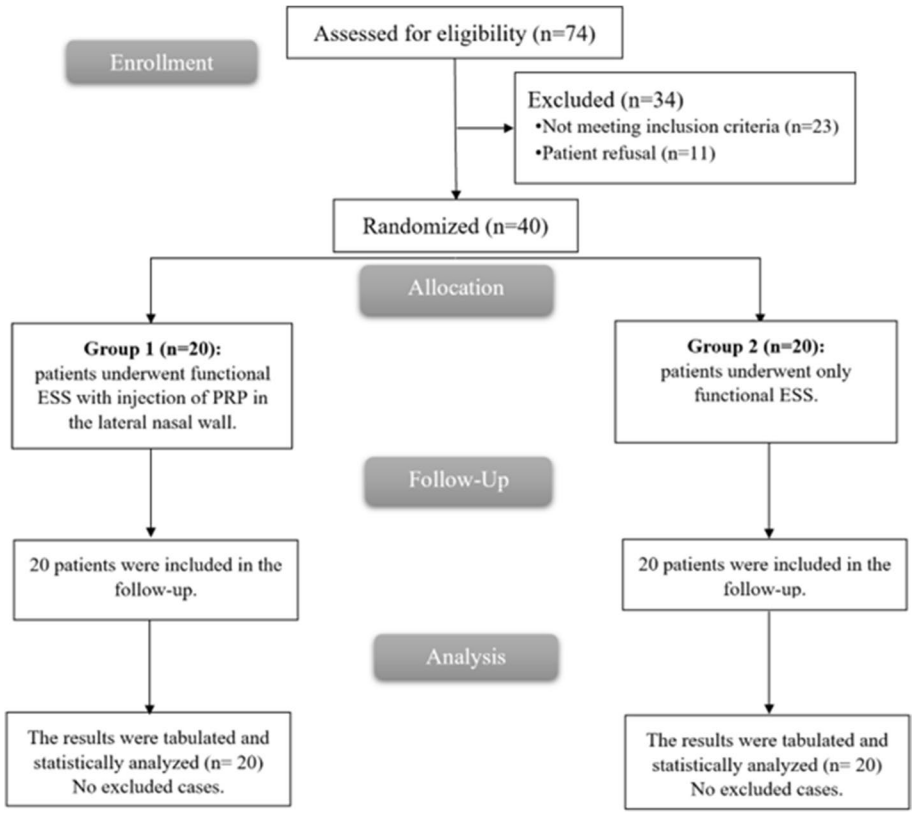

Fig. 9 CONSORT flowchart of the enrolled patients

Table 1 Comparison between the two studied groups according to pre- and post-operative Lund-Kennedy score

	Group 1 ($n=20$)	Group 2 ($n=20$)	*P*-value
Pre-operative			
Min.–Max	7.0–8.0	7.0–8.0	0.108
Median (IQR)	8.0 (7.0–8.0)	7.0 (7.0–8.0)	
After 1 month			
Min.–Max	2.0–3.0	2.0–4.0	0.108
Median (IQR)	3.0 (3.0–3.0)	3.0 (3.0–4.0)	
After 3 months			
Min.–Max	3.0–5.0	5.0–6.0	< 0.001*
Median (IQR)	4.0 (4.0–4.50)	6.0 (6.0–6.0)	
After 6 months			
Min.–Max	3.0–8.0	5.0–8.0	< 0.001*
Median (IQR)	4.50 (4.0–5.0)	6.0 (5.0–7.0)	
Percent of change			
Min.–Max	− 14.29–62.50	− 14.29–37.50	< 0.001*
Median (IQR)	40.18 (28.57–50.0)	14.29 (0.0–28.57)	

Group 1: CRSwNP underwent FESS + PRP injection

Group 2: CRSwNP underwent FESS only

p p value for comparing between the two studied groups

IQR interquartile range

*Statistically significant at $p \leq 0.05$

patients who underwent FESS with PRP injection, and Group 2 consisted of CRSwNP patients who underwent FESS only.

After 1 month, both groups exhibited improvement in scores, but the difference remained statistically insignificant ($p = 0.108$). However, significant differences emerged after 3 and 6 months. Group 1 had significantly lower Lund-Kennedy scores compared to Group 2 at both 3 months ($p < 0.001$) and 6 months ($p < 0.001$). By 3 months post-op, the edema, discharge, and total Lund-Kennedy scores remained significantly better in the PRP group compared to the controls. However, the polyp score was no longer significantly different, suggesting that the initial improvement in polyp burden did not persist long term with PRP. Improvement of polyp score was significantly different by 6 months follow-up but at 3 months there is improvement in overall score without significant improvement in polyp score.

Furthermore, the percent change in Lund-Kennedy scores showed a significantly greater improvement in Group 1 (median 40.18) compared to Group 2 (median 14.29) with a *p*-value of < 0.001 (Table 1).

Comparison between the two studied groups according to pre-operative Lund-Mackay score (radiological staging)

For the maxillary sinus, both groups had similar scores with a median of 2.0 and no statistically significant difference ($p=0.799$). Similarly, for the anterior ethmoid sinus, both groups had a median score of 2.0 with no significant difference ($p=0.799$). The posterior ethmoid sinus scores also showed no significant difference between the groups ($p=0.429$), with median scores of 2.0 for both (Table 2).

The sphenoid sinus scores were also comparable, with no significant difference ($p=0.799$), and both groups had a median score of 2.0. For the frontal sinus, while there was a slight variation in the mean scores, the difference was not statistically significant ($p=0.289$) (Table 2).

Table 2 Comparison between the two studied groups according to pre-operative Lund-Mackay score (radiological staging)

	Group 1 ($n=20$)	Group 2 ($n=20$)	*U*	*p*
Maxillary				
Min.–Max	1.0–2.0	1.0–2.0	190.0	0.799
Mean ± SD	1.90 ± 0.31	1.95 ± 0.22		
Median (IQR)	2.0 (2.0–2.0)	2.0 (2.0–2.0)		
Ant Ethmoid				
Min.–Max	2.0–2.0	1.0–2.0	190.0	0.799
Mean ± SD	2.0 ± 0.0	1.95 ± 0.22		
Median (IQR)	2.0 (2.0–2.0)	2.0 (2.0–2.0)		
Post Ethmoid				
Min.–Max	1.0–2.0	1.0–2.0	170.0	0.429
Mean ± SD	1.95 ± 0.22	1.80 ± 0.41		
Median (IQR)	2.0 (2.0–2.0)	2.0 (2.0–2.0)		
Sphenoid				
Min.–Max	1.0–2.0	1.0–2.0	190.0	0.799
Mean ± SD	1.60 ± 0.50	1.55 ± 0.51		
Median (IQR)	2.0 (1.0–2.0)	2.0 (1.0–2.0)		
Frontal				
Min.–Max	1.0–2.0	1.0–2.0	160.0	0.289
Mean ± SD	1.40 ± 0.50	1.60 ± 0.50		
Median (IQR)	1.0 (1.0–2.0)	2.0 (1.0–2.0)		
OMC				
Min.–Max	2.0–2.0	2.0–2.0	200.0	1.000
Mean ± SD	2.0 ± 0.0	2.0 ± 0.0		
Median (IQR)	2.0 (2.0–2.0)	2.0 (2.0–2.0)		
Total				
Min.–Max	10.0–12.0	9.0–12.0	196.0	0.925
Mean ± SD	10.85 ± 0.67	10.85 ± 0.81		
Median (IQR)	11.0(10.0–11.0)	11.0(10.0–11.0)		

p p value for comparing between the two studied groups

IQR interquartile range, *SD* standard deviation, *U* Mann Whitney test

*Statistically significant at $p \leq 0.05$

The osteomeatal complex (OMC) scores were identical in both groups, with a mean and median of 2.0, showing no significant difference ($p=1.000$). The total Lund-Mackay scores ranged from 10.0 to 12.0 in Group 1 and 9.0 to 12.0 in Group 2, with no significant difference between the groups ($p=0.925$) (Table 2).

Comparison between the two studied groups according to SNOT-22 score

Group 2 had a slightly higher median pre-operative SNOT-22 score of 79.50 compared to 77.50 in Group 1 ($p=0.003$) (Table 3).

After 6 months, Group 1 showed a remarkable reduction in SNOT-22 scores, with a median score of 7.0, whereas Group 2 had a median score of 45.0. This difference was statistically significant ($p<0.001$) (Table 3).

The percent change in SNOT-22 scores further highlights this improvement. Group 1 showed a median percent change of 90.91%, while Group 2 had a median percent change of 43.65% ($p<0.001$) (Table 3).

Comparison between the two studied groups according to relapse

There was a significant difference in relapse rates between the studied groups ($p=0.018$). In Group 1, 85.0% of patients (17 out of 20) did not experience a relapse, while only 15.0% (3 out of 20) had a relapse. In contrast, in Group 2, 50.0% of patients (10 out of 20) experienced a relapse, with the remaining 50.0% (10 out of 20) not having a relapse (Table 4).

Table 3 Comparison between the two studied groups according to SNOT-22 score

	Group 1 ($n=20$)	Group 2 ($n=20$)	*P*-value
Pre-operative			
Min.–Max	75.0–82.0	75.0 – 81.0	0.033*
Median (IQR)	77.50 (76.0–79.0)	79.50 (78.0 – 80.50)	
After 6 months			
Min.–Max	6.0–77.0	10.0 – 80.0	< 0.001*
Median (IQR)	7.0 (6.0–8.0)	45.0 (13.0 – 77.50)	
Percent of change			
Min.–Max	4.94–92.41	− 2.63–87.65	< 0.001*
Median (IQR)	90.91(89.87–92.05)	43.65(3.09–83.56)	

p p value for comparing between the two studied groups

IQR interquartile range

*Statistically significant at $p \leq 0.05$

Table 4 Comparison between the two studied groups according to relapse

Relapse	Group 1 ($n = 20$)		Group 2 ($n = 20$)		*P*-value
	No.	%	No.	%	
After 6 months					
No	17	85.0	10	50.0	**0.018***
Yes	3	15.0	10	50.0	

p *p* value for comparing between the two studied groups

*Statistically significant at $p \leq 0.05$

Discussion

Platelet-rich plasma contains a variant of growth factors which are important for wound healing such as platelet-derived growth factor (PDGF), transforming growth factor alpha (TGF-α), transforming growth factor beta (TGF-β), epidermal growth factor (EGF), fibroblast growth factor (FGF), and insulin like growth factor, all these factors facilitate rapid wound healing and haemostasis and decrease scarring. PRP is a novel material that is being used more and more nearly without complications or adverse effect because it is an autologous material.

In our study, the pre-operative radiological staging by the Lund-Mackay score and endoscopic staging by the Lund-Kennedy score were comparable between the groups, with no statistically significant differences. Similarly, the pre-operative SNOT-22 scores were not significantly different between groups.

These findings are consistent with other studies evaluating PRP in CRSwNP, such as Mohebbi et al. [6], who showed similar pre-operative characteristics.

In our study, at 1-month post-op, the Lund-Kennedy endoscopic scores demonstrated significantly better polyp scores, edema scores, and discharge scores in the PRP group compared to controls. However, the crusting score was higher in the PRP group.

These early benefits of PRP are in line with Dinaki et al. [7], showing short-term improvements with PRP, likely due to the initial healing properties of growth factors released from platelets.

In their study, Hassan et al. [8] found that endoscopic assessment of both middle meatuses revealed a notable reduction in the production of synechia, discharge, edema, and crusting on the PRP side during the initial visits after 1 week. Nevertheless, there was no statistically significant difference between the two sides in terms of discharge 1 month after the operation.

Salah El Din et al. [9] performed a study in which they randomly assigned participants to receive either topical PRP or a placebo after undergoing submucous diathermy. The purpose of the study was to assess the efficacy of topical PRP in this context. The trial had a total of 60 patients, who were separated into two groups. Among them, 30 patients underwent submucous diathermy followed by the administration of PRP. Subsequent evaluations were conducted at 3 days, 1 week, 2 weeks, 1 month, and 2 months after the surgery, in consecutive order. The researchers discovered that the PRP group had less crust development and bleeding. The researchers determined that nasal mucociliary clearance (NMC) showed a statistically significant improvement in the group that received PRP packing.

In a randomized trial, Kumar et al. [10] compared 74 septoplasty patients who received PRP to the same number of control group patients. Both groups improved NMC, but the PRP group had a statistically significant early restoration. Crust formation was lower in PRP. They found that PRP improves NMC function in septoplasty patients, speeding up nasal function recovery.

Kuzucu et al. [11] examined 53 patients who underwent nose surgery. Out of the total, 27 individuals were treated with PRP packing, whereas the control group included 26 patients. The postoperative follow-up involved comparing the Nose Obstruction Symptom Evaluation (NOSE) score, bleeding severity, pain level, and crust formation rate between the two groups. After a duration of 1 month, the PRP group exhibited superior outcomes in relation to the NOSE scale, reduced bleeding, and less crust development, all of which demonstrated statistical significance. Nevertheless, there was no statistically significant disparity in terms of the visual analog scale score for pain.

In our study, by 3 months post-op, the edema, discharge, and total Lund-Kennedy scores remained significantly better in the PRP group compared to the controls. However, the polyp score was no longer significantly different, suggesting that the initial improvement in polyp burden did not persist long term with PRP.

According to Dinaki et al. [7], the Lund-Kennedy score was considerably reduced in the PRP group after the 3-month follow-up, indicating improved outcomes in chronic rhinosinusitis for the patients in this group.

Sadek et al. [12] submitted that PRP enhances nasal mucosal wound healing and has a faster mechanism for decreasing mucosal edema. Following the nasal mucosal healing, at 3 days postoperative, then at 7 days, 14 days, and up to 1 month, there was an improvement in the healing of the nasal mucosa in the PRP group. The mean wound healing duration was significantly different between the two groups ($p < 0.001$).

In 2019, a study was conducted to assess the effectiveness of concentrated growth factors (CGF) derived

from blood plasma in repairing nasal septal mucosal abnormalities following rhinoplasty. The membranous CGF film was put onto the surface, while the produced liquid CGF was injected surrounding the wound. Every patient received treatment with CGF at intervals ranging from 3 to 5 days. All patients achieved full healing of the mucosal defect of the nasal septum, along with improved function and appearance, after undergoing 3 to 12 treatments. This study showed that the use of CGF effectively managed the localized infection and facilitated the healing process of the nasal mucosa defect following rhinoplasty [13].

In our study, the results at 6 months continued to show significantly better polyp, edema, discharge, and total Lund-Kennedy scores in the PRP group compared to the controls. The percent change in Lund-Kennedy scores from baseline to 6 months was also significantly greater in the PRP group. These findings indicate that PRP provided sustained benefits in reducing edema, discharge, and overall endoscopic symptoms through 6 months post-op.

Mohebbi et al. [6] demonstrated the beneficial impact of both FESS and PRP. Nevertheless, the endoscopic assessment of the nasal cavity area treated with PRP revealed a discernible distinction, but the decrease was not statistically significant when compared to the control side after a period of 6 months.

In the limited studies available, PRP application appears to result in significantly reduced crusting in nasal surgeries [11, 14].

Dinaki et al. [7] found a significant difference between the two groups over the whole postoperative period. During the initial week, 80% ($n=24$) of the sides in the control group had considerable crusting, which subsequently decreased to 56.6% ($n=17$) in the second week. Within the PRP group, 36.6% ($n=11$) of the observed sides had considerable crusting, which decreased to 16.6% ($n=5$) in the second week. During the eighth week, 12 out of the sides in the control group, which is 40% of the total, showed mild crusting. In comparison, just 5 sides in the PRP group, which is 16.6% of the total, displayed mild crusting.

Several recent clinical and animal investigations have investigated the therapeutic potential of PRP in treating anosmia [15, 16]. Most of these studies have investigated the use of PRP in the olfactory area for individuals suffering from anosmia caused by degeneration of the olfactory epithelium. PRP is believed to include a high amount of growth factors and neurotrophic factors. Therefore, it is anticipated that PRP might be an effective treatment for neuroregeneration. Hence, the injection of PRP has the potential to induce the regeneration of basal cells and provide a therapeutic method for treating anosmia [17]. These investigations have yielded extremely encouraging results in the treatment of anosmia [18].

In 2020, a study was undertaken to investigate the impact of submucosal PRP injection on wound healing in endonasal operations. This study was designed as an experimental investigation. This study included a cohort of 24 adult male New Zealand rabbits. Three homogeneous groups were randomly formed, including all animals. Group A was administered a submucosal PRP injection at the site of the injury. Group S was administered a solitary 0.7 cc dose of 0.9% NaCl submucosal injection into the affected mucosa. Group C did not get any injections. The study findings demonstrated the beneficial impact of PRP on the nasal mucosa. Based on these findings, the injection of PRP into the damaged nasal mucosa had effects that reduced synechia, softened mucus, and had anti-inflammatory properties [19].

However, Tabrizi et al. [17] found that there was no immediate impact on the restoration of the sense of smell in patients with sinonasal polyps after receiving an intranasal injection of PRP following their surgical procedure.

Rice et al. [20] conducted a study to evaluate the therapeutic effects of PRP in the healing process following endoscopic sinus surgery. The study included 30 patients with bilateral and symmetrical chronic rhinosinusitis who did not show improvement with standard therapy. Following 13 surgical procedures, subsequent assessments revealed no advantage in using PRP, leading to the premature termination of the trial.

In our study, the improvement in SNOT-22 quality of life scores at 6 months was significantly greater in the PRP group, with a median decrease of 90.91% versus only 43.65% in the control group.

According to the study conducted by Mohebbi et al. [6], the most often reported symptoms by patients, as measured by SNOT-22, were the urge to expel mucus from the nose, nasal blockage, and discharge from the back of the nose. These symptoms showed a substantial decrease 6 months after the administration of PRP. The study of patient's symptoms based on the data from the SNOT-22 questionnaire showed a substantial decrease after 6 months.

A study conducted in 2016 included 4 intranasal injections of PRP in the olfactory area (3 injections 4 weeks apart and the 4th injection 3 months after the previous one) in 5 patients with severe anosmia. Four out of five patients reported complete smell recovery with PRP injections, which could hypothetically relate to the significantly improved symptom scores [21].

Additionally, the impact of a solitary PRP injection on individuals with olfactory impairment (OD) that persists for more than 6 months was evaluated. This study involved seven individuals with non-sinonasal OD who

did not respond to the usual treatment, which consisted of budesonide nasal irrigations and olfactory training. Following the administration of PRP injections, all patients had a noticeable enhancement in their olfactory perception. Patients with mild OD (Sniffin' Sticks olfactory test (TDI) score between 16 and 30) showed a 3-month improvement, but patients with anosmia (TDI score below 16) did not benefit from PRP treatment [16].

Previous investigations have indicated that PRP has the ability to both stimulate the olfactory system and generate new receptors [18].

Hassan et al. [8] found that subjective evaluation indicated superior outcomes in the nasal cavity when using PRP in terms of discomfort, headache, and nasal obstruction. However, the statistical significance was observed only in relation to discomfort, not blockage.

In a retrospective study conducted by [22], 16 patients who underwent endoscopic sinus surgery (ESS) for chronic sinusitis were given platelet gel for sinus packing. Another group of 16 control patients did not receive platelet gel. The study aimed to assess the impact on quality of life, which was measured using the "SNOT-16" questionnaire (Sinonasal Outcome Test, consisting of 16 questions). The questionnaire was administered both before and after the surgery. There were zero instances of synechia. There were no instances when postoperative bleeding occurred that required the use of packing. While the small population size prevented the result from being statistically significant, the quality of life measures did demonstrate improvement compared to the control group.

In our study, the relapse rate requiring revision surgery by 6 months was significantly lower at 15% in the PRP group versus 50% in the control group. This marked reduction in surgical failures with PRP correlates with improved objective endoscopic scores and symptoms. The dramatically lower 15% relapse rate with PRP injection is unprecedented and highlights the potential of this adjunctive therapy to improve surgical outcomes for CRSwNP.

Since PRP is a substance derived from one's own blood, it is not considered a drug.

A PRP injection is a low-risk procedure and does not usually cause major side effects. The procedure involves a blood draw, so one should make sure patients are hydrated and have eaten beforehand to prevent feeling lightheaded. After the procedure, patient may experience some soreness and bruising at the injection site [23]. Because PRP injections are made up of patient own cells and plasma, the risk of an allergic reaction is much lower than with other injectable medications like corticosteroids. Less common risks of PRP injections include bleeding, tissue damage, infection, and nerve injuries [24, 25]

The use of platelet-rich plasma has become widespread, and we need to conduct more studies to maximize the benefit, taking into account the following: longer follow-up periods, larger multi-centre trials, and studies focusing on the optimal composition and concentration of PRP.

Our study had some limitations as single-centre study with relatively small sample size and shorter duration of follow-up.

Conclusions

PRP injection during FESS significantly reduces the recurrence of sinonasal polyps and improves clinical outcomes in patients with CRSwNP. These findings suggest PRP as a promising adjunctive treatment to enhance surgical outcomes and reduce healthcare burdens associated with recurrent sinonasal polyposis. Further larger randomized clinical trials with longer duration of follow-up are needed to validate our findings.

Abbreviations

CRSwNP	Chronic rhinosinusitis with nasal polyps
CRS	Chronic rhinosinusitis
ESS	Endoscopic sinus surgery
PRP	Platelet-rich plasma
FESS	Functional endoscopic sinus surgery
CT	Computed tomography
IQR	Interquartile range
IBM	International Business Machines Corporation
SPSS	Statistical Package for the Social Sciences
SNOT-22	Sino-Nasal Outcome Test, 22-item
OMC	Osteomeatal complex
NMC	Nasal mucociliary clearance
NOSE	Nose obstruction symptom evaluation
CGF	Concentrated growth factors
OD	Olfactory dysfunction
TDI	Threshold, Discrimination, and Identification (part of the Sniffin' Sticks olfactory test)
SNOT-16	Sinonasal Outcome Test, 16-item
SD	Standard deviation

Authors' contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by AMA, AFG, ASE, and AAE. The first draft of the manuscript was written by AAE and AMA, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding

None to be declared.

Data availability

The data is available upon reasonable request from the authors.

Declarations

Ethics approval and consent to participate

The study was approved from the institutional ethical committee, Benha University. After receiving written informed consent from each subject, the study was carried out with their permission after receiving approval from the Institutional Review Board (IRB) of the Benha University Faculty of Medicine.

Consent for publication

None to declare.

Competing interests
The authors declare that they have no competing interests.

Received: 25 May 2024 Accepted: 4 October 2024
Published online: 23 December 2024

References

1. Marglani O, Al Abri R, Al Ahmad M et al (2023) Management of Chronic Rhinosinusitis with Nasal Polyps (CRSwNP) in the Pan-Arab region: consensus recommendations from a multidisciplinary expert working group. J Asthma Allergy 16:1055–1063. https://doi.org/10.2147/jaa.S413610
2. Kaboodkhani R, Bolkheir A, Esmaeilzadeh H et al (2021) Aspirin exacerbated respiratory disease and nasal polyp phenotyping. Iran J Pharm Res 20:21–8. https://doi.org/10.22037/ijpr.2021.114924.15113
3. Abdelsamie AM, Abdelazeem HM, Dawood GK et al (2024) Prognostic value of polypoid changes of the middle turbinate in relapsed nasal polypi after FESS: A Prospective Cohort Study. Int Arch Otorhinolaryngol 28:e226–e233. https://doi.org/10.1055/s-0043-1776730
4. Koupenova M, Livada AC, Morrell CN (2022) Platelet and megakaryocyte roles in innate and adaptive immunity. Circ Res 130:288–308. https://doi.org/10.1161/circresaha.121.319821
5. Hassan O, Ibrahim M, ElFarouk A et al (2020) Platelet-rich plasma nasal packing in endoscopic sinus surgery. PAJN 10:94–99
6. Mohebbi A, Hosseinzadeh F, Mohebbi S et al (2019) Determining the effect of platelet-rich plasma (PRP) on improving endoscopic sinus surgery: a randomized clinical trial study (RCT). Med J Islam Repub Iran 33:150. https://doi.org/10.34171/mjiri.33.150
7. Dinaki K, Grigoriadis N, Vizirianakis IS et al (2024) The impact of submucosal PRP injection on wound healing after endoscopic sinus surgery: a randomized clinical trial. Eur Arch Otorhinolaryngol. https://doi.org/10.1007/s00405-024-08483-6
8. Hassan O, Ibrahim M, ElFarouk A et al (2020) Platelet-rich plasma nasal packing in endoscopic sinus surgery. Pan Arab Jour Rhinology 10:94–99
9. Salaheldin AH, Hussein A (2012) Effect of platelet-rich plasma on nasal mucociliary clearance after submucous diathermy of inferior turbinate. Egyptian Journal of Ear, Nose, Throat and Allied Sciences. 13:71–75. https://doi.org/10.1016/j.ejenta.2012.03.003
10. Kumar MM (2017) Role of platelet-rich plasma on nasal mucociliary clearance after septoplasty–a randomized clinical study. Int J Sci Stud 5:71–75
11. Kuzucu I, Beriat GK, Ezerarslan H et al (2017) Effects of the autologous platelet-rich plasma in nasal pack on postoperative quality of life. J Craniofac Surg 28:e299–e302. https://doi.org/10.1097/scs.0000000000003664
12. Sadek AA, Hassan ME, Zayed MN, et al. Role of Platelet Rich Plasma in Mucosal Healing After Nasal Surgeries. *EJENTAS*. 2023;24:1–6. https://doi.org/10.21608/ejentas.2022.144691.1529
13. Zhao QM, Gao J, Huang XX et al (2020) Concentrated growth factors extracted from blood plasma used to repair nasal septal mucosal defect after rhinoplasty. Aesthetic Plast Surg 44:511–516. https://doi.org/10.1007/s00266-019-01474-7
14. Sari H, Karaketir S, Kumral TL et al (2021) The effect of platelet-rich fibrin (PRF) on wound healing, adhesion, and hemostasis after endoscopic sinus surgery in patients with nasal polyposis. Am J Otolaryngol 42:103010. https://doi.org/10.1016/j.amjoto.2021.103010
15. Tutar B, Ekincioglu E, Karaketir S et al (2020) The impact of platelet-rich fibrin (PRF) on olfactory function and pain after septoplasty operations. Eur Arch Otorhinolaryngol 277:1115–1120. https://doi.org/10.1007/s00405-020-05839-6
16. Yan CH, Mundy DC, Patel ZM (2020) The use of platelet-rich plasma in treatment of olfactory dysfunction: a pilot study. Laryngoscope Investig Otolaryngol 5:187–193. https://doi.org/10.1002/lio2.357
17. Tabrizi A, Asadi M, Mohammadi M et al (2021) Efficacy of platelet-rich plasma as an adjuvant therapy to endoscopic sinus surgery in anosmia patients with sinonasal polyposis: a randomized controlled clinical trial. Med J Islam Repub Iran 35:156. https://doi.org/10.47176/mjiri.35.156
18. Yasak AG, Yigit O, Araz Server E et al (2018) The effectiveness of platelet-rich plasma in an anosmia-induced mice model. Laryngoscope 128:E157–E162. https://doi.org/10.1002/lary.27029
19. Patel GB, Kern RC, Bernstein JA et al (2020) Current and future treatments of rhinitis and sinusitis. J Allergy Clin Immunol Pract 8:1522–1531. https://doi.org/10.1016/j.jaip.2020.01.031
20. Rice DH (2006) Platelet-rich plasma in endoscopic sinus surgery. Ear Nose Throat J 85(516):8
21. Mavrogeni P, Kanakopoulos A, Maihoub S et al (2017) Anosmia treatment by platelet rich plasma injection. Int Tinnitus J 20:102–105. https://doi.org/10.5935/0946-5448.20160019
22. Pomerantz J, Dutton JM (2005) Platelet gel for endoscopic sinus surgery. Ann Otol Rhinol Laryngol 114:699–704. https://doi.org/10.1177/000348940511400908
23. Kaux JF, Croisier JL, Léonard P et al (2014) Exuberant inflammatory reaction as a side effect of platelet-rich plasma injection in treating one case of tendinopathy. Clin J Sport Med 24:150–152. https://doi.org/10.1097/JSM.0b013e31829aa410
24. Zhang W, Guo Y, Kuss M et al (2019) Platelet-rich plasma for the treatment of tissue infection: preparation and clinical evaluation. Tissue Eng Part B Rev 25:225–236. https://doi.org/10.1089/ten.TEB.2018.0309
25. Nanda S, Chauhan K, Shetty V et al (2021) Platelet-rich plasma in aesthetics. Indian Dermatol Online J 12:41–54. https://doi.org/10.4103/idoj.idoj_290_21

Publisher's Note