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EFFICACY OF AUTOLOGOUS PLATELET RICH FIBRIN IN OSSEOUS REGENERATION AFTER ENUCLEATION OF ODONTOGENIC CYSTIC JAW LESIONS: A PROSPECTIVE STUDY

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Abstract

Objective: *The objective of this study was to evaluate the effectiveness of autologous platelet-rich fibrin (PRF) in enhancing osseous regeneration and pain reduction following the enucleation of odontogenic cysts.*

Background: *Odontogenic cystic jaw lesions are pathological cavities or cysts that develop within the jawbone because of abnormal growth of the tissues related to tooth development.*

Methodology: *A prospective observational study was conducted in OMFS department of PIMS from February till November 2025 after ethical approval. Sample size was calculated by using WHO sample size calculator which was 32 patients. Either gender, aged 18 years and above with odontogenic cyst in maxilla and mandible were included. After enucleation, the cystic cavity was filled with autologous Platelet-Rich Fibrin (PRF) followed by repositioning of mucoperiosteal flap and suturing with vicryl 3/0. These patients were assessed for osseous regeneration and pain.*

Data Analysis: *Data was analyzed through SPSS V27.0. Frequency and percentages were calculated for qualitative variables whereas mean and standard deviation were calculated for quantitative variables.*

Results: *The 32 patients diagnosed with odontogenic cysts underwent enucleation. Demographic data showed that patients were predominantly male (71.9%) with mean age 25.66 ± 7.97 year. Majority of patients demonstrated satisfactory PRF mediated osseous regeneration and significant reduction in post-operative pain values ($P < 0.001$).*

Conclusion: *Autologous platelet-rich fibrin is a safe, cost-effective, and biologically favorable adjunct for enhancing osseous regeneration and achieving consistent pain relief following enucleation of odontogenic cysts.*

INTRODUCTION:

Odontogenic cystic jaw lesions are pathological cavities or cysts that develop within the jaw bone because of abnormal growth of tissues related to tooth development (odontogenic tissues). These cysts typically originate from remnants of epithelial lining or dental tissue remnants in the jaw bone, commonly affecting the maxilla and mandible. They vary in size and presentation, often causing local swelling, bone expansion, and displacement of adjacent teeth. [1] Odontogenic cystic jaw lesions pose unique challenges in oral and maxillofacial surgery due to their potential for recurrence and associated complications. Enucleation remains a relevant treatment method that centers on the excision of the cystic lining followed by the healing of bone tissue. Modern diagnostic methods enable proper evaluation of the lesion prior to the surgical intervention, thus providing positive outcomes without causing harm to the individual.[2]

Regeneration refers to the proliferation of damaged tissues during healing. Reconstruction of bony defects represents a challenge for the surgical community. Spontaneous bone regeneration in untreated defects is limited to small areas because of the rapid proliferation of surrounding soft tissue. [3] Bone grafts and bone regeneration materials are used with varying degrees of success. Graft materials include autografts, allografts, xenografts, and synthetic bone substitutes. Xenografts and allografts are well documented as suitable bone replacement grafts; however, incomplete resorption of these materials is frequently reported, and a risk of disease transmission still exists. The autologous bone grafts are considered the gold standard, but they have disadvantages such as limited availability, the need for an additional operation, and the risk of postoperative pain, paresthesia, and infection. [4] Techniques such as the use of bone grafts and bone substitutes, guided tissue regeneration (GTR), and, more recently, the application of polypeptide growth factors (PGFs) to surgical wounds are commonly employed to promote bone regeneration. Autologous platelet-rich plasma (PRP) and platelet-rich fibrin (PRF) are the novel methods for obtaining autologous PGFs, specifically platelet-derived growth factor (PDGF) and transforming growth factor β (TGFβ).[5] In oral surgery, two kinds of platelet concentrates are used for in vivo tissue engineering applications: PRP and PRF. Platelet concentrates are suspensions of growth factors found within the platelets which act as bioactive surgical additives applied locally to induce wound healing.[6] PRF was first used specifically in oral surgery by Dohan et al.[7] and was considered a new generation of platelet concentrate. It consists of a matrix of autologous fibrin and has several advantages over PRP, including easier preparation and the absence of chemical manipulation of blood, making it strictly an autologous preparation.[8] PRF consists of an autologous leukocyte–platelet-rich fibrin matrix composed of a tetramolecular structure with cytokines, platelets, and stem cells, which acts as a biodegradable scaffold that favors micro

vascularization and guides epithelial cell migration to its surface.[9–10] This study investigated the effectiveness of autologous platelet-rich fibrin (PRF) in promoting bone regeneration following the enucleation of odontogenic cysts of the maxilla and mandible. Odontogenic cysts are frequently encountered in dental practice and could lead to significant morbidity if not managed properly. Traditional surgical approaches sometimes result in delayed healing or complications, highlighting the need for enhanced regenerative techniques. PRF, known for its rich growth factors and its ability to promote healing, presents itself as a promising adjunct in dental surgery.

METHODOLOGY:

A prospective observational study was conducted in the Department of Oral and Maxillofacial Surgery (OMFS) at the Pakistan Institute of Medical Sciences (PIMS), Islamabad from February to November 2025. Ethical approval for the study was obtained from the Ethical Review Board of Shaheed Zulfiqar Ali Bhutto Medical University. A non-probability consecutive sampling technique was employed to recruit patients and total of 32 patients were calculated using the WHO sample size calculator, based on a 95% confidence level and a population mean osteosynthesis score of 1.4563 with 0.50% absolute precision.[5] Informed consent was obtained from all participants prior to enrollment. Male and female patients aged 18 years and above with odontogenic cysts in maxilla and mandible were included. Patients with secondarily infected cysts causing fascial space infections, uncontrolled diabetes, history of chemotherapy and radiotherapy of head and neck in last one year, alcoholics, smokers and patients on oral contraceptives were excluded from the study. Eligible patients were scheduled for surgery after complete clinical and radiographical evaluation by a maxillofacial surgeon. A structured proforma was used to collect demographic information such as gender, age, education, socioeconomic status and occupation. Pre- and post-operative bone density of cystic area was measured on OPG using ImageJ software and the pre- and post-operative pain was recorded through the widely used Visual Analog Scale (VAS). Under local or general anesthesia, a buccal gingival incision was made followed by elevation of a full thickness mucoperiosteal flap to expose the cystic cavity. The cyst was carefully enucleated, and the resulting bony defect was filled with autologous platelet-rich fibrin (PRF), after which the mucoperiosteal flap was repositioned and closed using 3-0 vicryl sutures in either interrupted or continuous fashion. PRF was prepared following the Choukroun et al. protocol.[11] For each 1 cm of bony cavity, 10 ml of intravenous blood was drawn from the antecubital vein into a sterile vacutainer tube without anticoagulant.[12] The blood was immediately centrifuged at 3000 rpm for 10 minutes.[13] This allowed formation of a structured fibrin clot between the red blood cell layer at the bottom and platelet-poor plasma at the top. The fibrin clot was gently separated using sterile tweezers and scissors, preserving a thin red cell layer, and was then placed into the cystic cavity. Postoperative monitoring was done and standard postoperative medications and written instructions were provided. Subsequent assessment of bone density was performed on an Orthopantomogram (OPG) at 3- and 5-months using grayscale histogram in ImageJ software. The pain follow-up using the VAS was done at 48hrs, 72hrs and 7th post-op day.

DATA ANALYSIS:

Data analysis was conducted through SPSS version 27.0 software. Descriptive statistics were used for the characterization of demographic data. Mean and standard deviations were calculated for quantitative data such as age and grayscale measurements. Frequency and percentages were calculated for qualitative data. Difference in pre- and postoperative bone density levels was calculated at 3rd and 5th post-operative month by OPG and ANOVA. Postoperative pain was compared with pre-operative levels using paired t-tests at 48hrs, 72hrs and 7th post-operative day. Preoperative and postoperative changes in greyscale showing the effect of PRF on osseous regeneration were presented using appropriate tables and graphs. A p-value of <0.05 was considered statistically significant.

RESULTS:

A total of 32 patients diagnosed with odontogenic cysts underwent enucleation followed by placement of PRF in the cystic cavity. Demographic data showed that out of all the patients enrolled, males were predominant (71.9%) with mean age of 25.66 ± 7.97 years; 81.3% of the people were rural residents, 56.3% were middle class, and 46.9% were students.

Repeated measures ANOVA results demonstrate satisfactory PRF effect in osseous regeneration over a period of 5 months ($P < 0.001$). Similarly, 62.5% reported mild pain and 25.0% moderate pain, pre-operatively which reduced to 90.6% patients being completely pain-free and 9.4% having mild pain after surgery.

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Table No 1. Baseline Demographic data of Patients with Odontogenic Cysts (N=32)

Variable		Frequency (%)	Mean Age
Gender	Male	23 (71.9%)	25.66±7.97
	Female	9 (28.1%)	
Marital Status	Single	5 (16.0%)	
	Married	21 (65.0%)	
	Divorced	4 (14.0%)	
	Widowed	2 (5.0%)	
Address	Urban	6 (18.8%)	
	Rural	26 (81.3%)	
Socioeconomic Status	Lower Class	12 (37.5%)	
	Middle Class	18 (56.3%)	
	Upper Class	2 (6.3%)	
Education Level	Uneducated	4 (12.5%)	
	Educated	28 (87.5%)	
Employment Status	Employed	10 (31.25%)	

	Unemployed	22(68.75%)

Figure I: Shows that the reported odontogenic cysts were most commonly present in posterior mandible and accounted for 16(50.0%) cases (left 25% and right side 25%) followed by anterior mandible as 5(15.6%). Reported cases in maxilla were 11(34.37%) as at right posterior maxilla 5 (15.63%), 4(12,5%) left posterior of maxilla and 2(6.25%) at anterior area of maxilla.

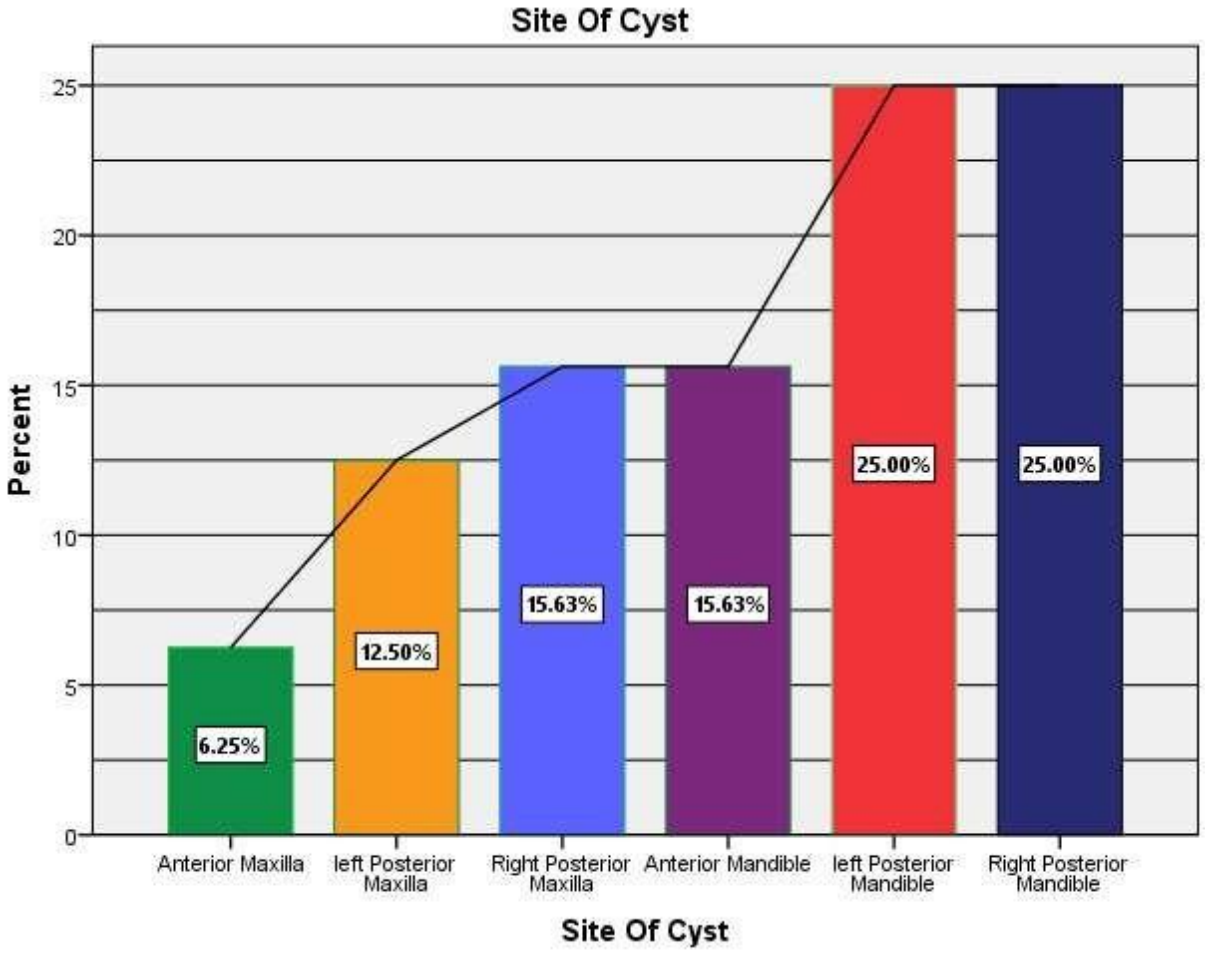

Figure I: Shows the Distribution of Site of Odontogenic Cyst (N=32)

The normality of the quantitative data was assessed through Shapiro wilk test. The variables which were not normally distributed were calculated through median/inter quartile range (IQR). On the other hand, variables which were normally distributed were calculated through mean and standard deviation as shown in table II. Table No II shows the cyst size with median 1.90, IQR 0.69. Preoperative pain scores showed a median of 2.00 (IQR 0.75) which improved significantly to a median of 0.00 (IQR 0.00; non-normal) at 3 months postoperatively. Grayscale scores, which were normally distributed, decreased from 123.46 ± 33.36 preoperatively to 102.81 ± 29.69 at 3 months then increased to 119.66 ± 31.43 at 5 months postoperatively. Conversely, grayscale areas increased from a median of 3127 (IQR 1484) preoperatively to 3397 (IQR 1422) at 3 months and 3363 (IQR 1420) at 5 months postoperatively. Descriptive statistics stratified by normality are presented in Table No II.

Table No. II: Distribution-Based Descriptive Statistics for Cyst Size, Pain Scales, and Grayscale Metrics in Odontogenic Cysts (N=32)

Variable	Distribution	N	Minimum	Maximum	Mean ±SD	Median (IQR)
Size of cyst (cm)	Non-normal	32	0.5	2.0	-	1.90 (0.69)
Grayscale Score Pre-operatively	Normal	32	52.82	187.90	123.46±33.36	-
Grayscale Score 3 months post-operatively	Normal	32	56.92	165.69	102.81±29.68	-
Grayscale Score 5 months post-operatively	Normal	32	69.93	178.45	119.67±31.43	-
Grayscale Area Pre Operatively	Non-normal	32	629.0	4794.0	2987.91±980.16	3127 (1484)
Grayscale Area 3 months Post Operatively	Non-normal	32	752.0	4980.0	3247.06±997.26	3397 (1422)
Grayscale Area 5 months Post Operatively	Non-normal	32	792	4994.0	3285.09±990.67	3363 (1420)
Preoperatively Pain Scale	Non-normal	32	0.0	3.0	-	2.0 (0.75)
Pain scale 72hrs Post Operatively	Non-normal	32	0	1.0	-	0.0 (0.00)
Pain scale 7-day Post Operatively	*	32	0	0	-	0.0 (0.00)

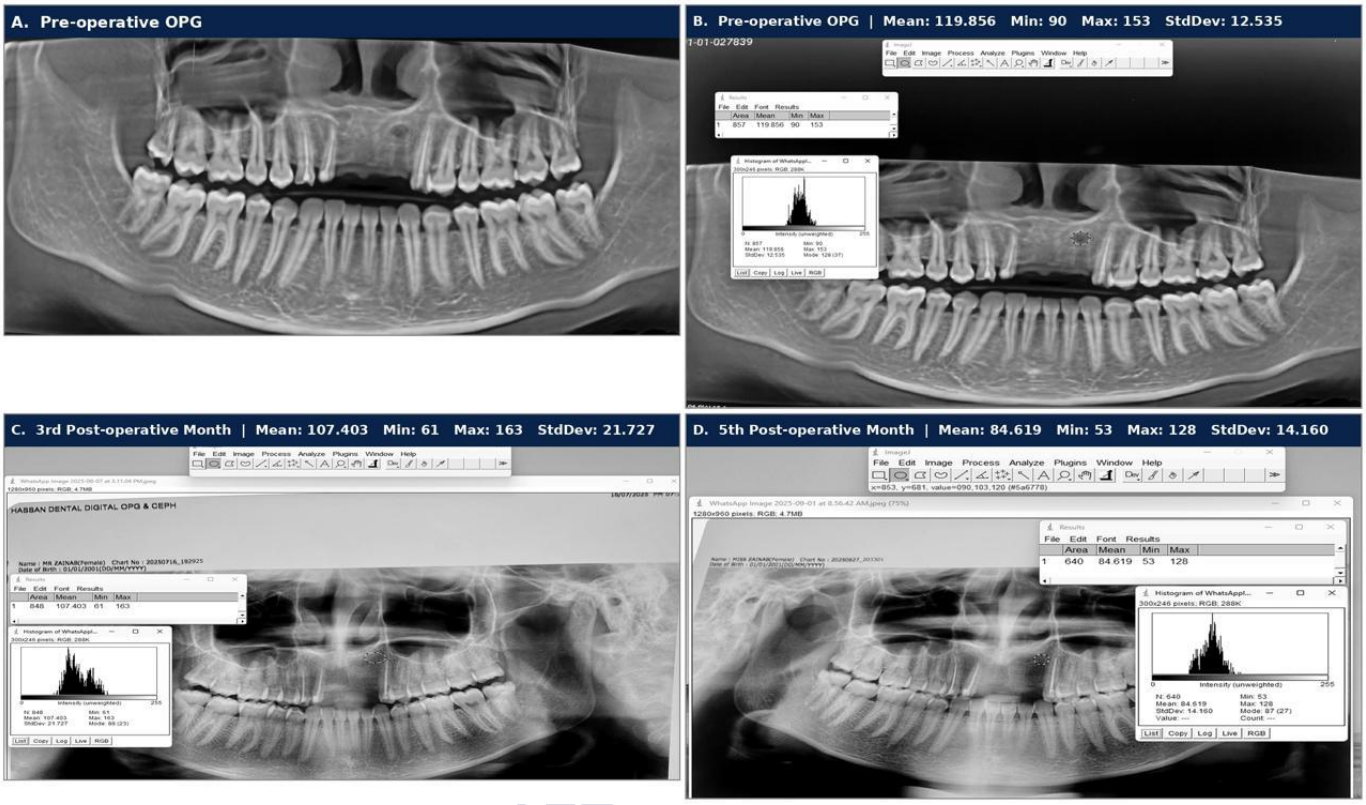

Figure II: Grayscale orthopantomogram demonstrating progressive osseous regeneration following odontogenic cyst enucleation with Platelet-Rich Fibrin at pre-operative, 3rd and 5th post-operative months.

Table: Grayscale Histogram Values — Pre-op, 3rd and 5th Post-operative Months

Grayscale Parameter	Pre-operative	3rd Month Post-op	5th Month Post-op
Mean Grayscale Score	119.856	107.403	84.619
Minimum Value	90	61	53
Maximum Value	153	163	128
Area (N pixels)	857	848	640
Standard Deviation	12.535	21.727	14.160

Grayscale histogram analysis of the cystic defect using ImageJ software showing mean, standard deviation at pre-operative, 3rd post-operative and 5th post-operative months

Radiographic outcomes demonstrated PRF efficacy in osseous regeneration: grayscale scores (inversely related to bone density) decreased significantly post-enucleation in both genders (males: 116.24 → 94.96 at 3 months [-18%]; females: 141.92 → 122.87 [-13%]), with partial remodeling toward baseline by 5 months. Females maintained consistently higher grayscale values (less dense bone) throughout all timepoints. Homogeneity of variances was confirmed across genders (Levene P > 0.05 as shown in Table No III

Table No. III: Gender-Stratified Grayscale Scores Demonstrating PRF-Mediated Osseous Regeneration (N=32)

Time Point	Gender	N	Mean ± SD	95% CI	Min-Max	Levene P
Pre-enucleation	Male	23	116.24 ± 33.31	101.83-130.64	52.82-186.56	0.736
	Female	9	141.92 ± 26.96	121.19-162.64	119.85-187.90	
3 Months Postop	Male	23	94.96 ± 29.53	82.19-107.73	56.92-165.69	0.435
	Female	9	122.87 ± 19.68	107.74-138.00	100.98-157.20	
5 Months Postop	Male	23	115.32 ± 33.94	100.64-129.99	69.93-178.45	0.110
	Female	9	130.74 ± 21.62	114.12-147.36	107.40-173.62	

*Notes: Levene's test confirms equal variances across genders (all P > 0.05). SD = standard deviation

62.5% of the patients reported mild pain pre-operatively establishing the baseline for comparison. Pre-operative pain free rate improved from 37.5% to 65% at 48hrs, 90.6% at 72hrs, and reaching 97.3% at the 7th post-operative day. It shows that PRF is highly efficacious in post-op pain resolution.

Table No. IV Wilcoxon Signed-Rank Test Results for Pain Scale Changes (N=32)

Comparison	VAS	Pain free	Z - value	P-value	Significance
Pre-operative	Mild Pain	37.5%	-	-	Baseline
48hrs postop vs. preoperative	Mild to Minimal Pain	65.0%	-	-	Improving
72hrs postop vs. Preoperative	Minimal Pain	90.6%	-4.809	< 0.001	Highly Significant
7 days Postop vs. Preoperative	No Pain	97.3%	-4.782	< 0.001	Highly Significant

DISCUSSION:

A prospective study was carried out with the purpose of assessing the efficacy of autologous platelet-rich fibrin (PRF) on osseous regeneration following the removal of odontogenic cystic lesions.

The study comprised 32 patients (N=32) with a mean age of 25.66±7.97 years. Gender distribution revealed a male predominance with

23 males (71.9%) and 9 females (28.1%). Regarding marital status, 5 patients (16.0%) were single, 21 (65.0%) were married, 4 (14.0%) were divorced, and 2 (5.0%) were widowed. In terms of residential address, the majority were from rural areas comprising 26 patients (81.3%) while 6 (18.8%) were from urban areas. Socioeconomic stratification revealed that 12 patients (37.5%) belonged to the lower class, 18 (56.3%) to the middle class, and 2 (6.3%) to the upper class. Regarding education, 28 patients (87.5%) were educated and 4 (12.5%) were uneducated. Regarding employment, 10 patients (31.25%) were employed while 22 (68.75%) were unemployed.

Descriptive statistics for the key study variables revealed important findings across all time points. The size of the odontogenic cysts followed a non-normal distribution, ranging from a minimum of 0.5 cm to a maximum of 2.0 cm, with a median of 1.90 cm (IQR: 0.69). Pre-operative grayscale scores followed a normal distribution with a minimum of 52.82, maximum of 187.90, and mean of 123.46±33.36 among all 32 patients. At 3 months post-operatively, grayscale scores again followed a normal distribution, ranging from 56.92 to 165.69 with a mean of 102.81±29.68. At 5 months post-operatively, grayscale scores remained normally distributed ranging from 69.93 to 178.45 with a mean of 119.67±31.43.

About grayscale area measurements, which followed a non-normal distribution at all time points, the pre-operative grayscale area ranged from a minimum of 629.0 to a maximum of 4794.0, with a mean of 2987.91±980.16 and a median of 3127 (IQR: 1484). At 3 months post-operatively, the grayscale area ranged from 752.0 to 4980.0 with a mean of 3247.06±997.26 and a median of 3397 (IQR: 1422). At 5 months post-operatively, the grayscale area ranged from 792.0 to 4994.0 with a mean of 3285.09±990.67 and a median of 3363 (IQR: 1420), confirming progressive osseous fill of the defect over time.

Pain scale measurements also followed a non-normal distribution throughout the study period. Pre-operatively, pain ranged from 0.0 to 3.0 with a median of 2.0 (IQR: 0.75). At 72 hours post-operatively, pain ranged from 0 to 1.0 with a median of 0.0 (IQR: 0.00), reflecting near-complete pain resolution. At 7 days post-operatively, pain ranged from 0 to 0 with a median of 0.0 (IQR: 0.00), indicating complete pain resolution in most patients.

The study results reveal significant reduction in postoperative pain levels during the 1st post-operative week. Pre-operatively, 62.5% of patients reported mild pain on the VAS scale, with only 37.5% being pain-free, establishing the baseline for comparison. At 48 hours post-operatively, VAS improved to mild-to-minimal pain with the pain-free rate rising to 65.0%, indicating an improving trend, though formal statistical testing was not performed at this time point. At 72 hours post-operatively, VAS showed minimal pain with 90.6% of patients being pain-free; the Wilcoxon Signed-Rank Test confirmed this to be a highly significant improvement compared to baseline ($Z=-4.809$, $P<0.001$). By the 7th post-operative day, 97.3% of patients reported no pain on VAS, again confirmed as highly significant compared to pre-operative levels ($Z=-4.782$, $P<0.001$). These findings demonstrate that PRF is highly efficacious in post-operative pain resolution.

According to Miron et al.[14] the beneficial effects may be explained by a constant delivery of growth factors like TGF-β and PDGF, which regulate inflammatory processes and help alleviate post-operative pain. Similar conclusions have been reached in the work of Öncü E et al.[15], where there is evidence of lower pain levels following PRF-based intervention in patients with odontogenic cysts. As far as stable pain levels are concerned, this means that not only do the healing rates increase due to PRF, but there is also an opportunity for achieving greater clinical comfort, an issue that has been discussed by Alauddin MS et al.[16]

Using the method of grayscale histogram analysis on orthopantomograms, radiographic bone density was assessed by ImageJ software. During the follow-up period, there was a gradual decrease in gray scale values at three months in comparison with preoperative values, which shows the increased bone density in the cystic defects till 3 post-op months, followed by remodeling towards baseline at five months showing a considerable decrease in greyscale value and hence increase in

bone density even more. The statistical analysis performed by means of repeated measures ANOVA revealed a significant impact of PRF on osseous regeneration ($P < 0.001$), with a large effect size ($\eta p^2 = 0.490$), meaning that almost half of the variations are explained by PRF application. These conclusions are also consistent with the findings by Nofriansyah R et al[17] who noted that PRF leads to fast bone maturation. A very similar conclusion has been made by Albina V et al[18], who reported increased radiographic density after PRF treatment.

Female patients in the sample have higher gray scale values, implying relatively lower bone density at each time interval. Although the differences are not statistically significant, they still may be linked to the research conducted by Biguetti CC et al[19], according to which women have different bone regeneration dynamics due to hormonal and metabolic reasons. However, based on Levene's test, one should state that PRF is similarly effective for male and female patients in terms of osseous regeneration. It should be noted that several recent papers have discussed how PRF provides an equivalent outcome as spontaneous healing in cystic defects. For example, according to Zain Elabdin AM et al[20] there was no significant difference in bone density between PRF-filled and non-PRF filled cystic defects six months after surgery. The differences may be accounted for using different radiographic methods, larger defect sizes, longer observation period, and PRF preparation techniques. Thus, one may say that the current paper uses the standardized Choukroun technique in combination with grayscale histogram analysis on OPG, while some studies relied on CBCT volumetric analyses. The osseous regeneration after enucleation of odontogenic cysts is critical for ensuring the return of function, studies also emphasize upon the importance of proper surgical techniques and use of biomaterials towards achieving optimum results. In fact, noticeable improvement at three months and remodeling at five months reflects normal bone regeneration enhanced by PRF.

CONCLUSION:

Autologous platelet-rich fibrin is a safe, cost-effective, and biologically advantageous approach to promote osseous regeneration in odontogenic cysts. Over a five-month period, the trial showed favorable remodeling patterns, consistent pain relief, and a notable improvement in bone density. In the treatment of maxillofacial cystic defects, PRF is a promising regenerative biomaterial that can enhance postoperative results and lower patient morbidity.

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