

Research Article

The Role of Growth Factors in Enhancing Wound Healing and Reducing Post-Operative Complications after Minor Maxillofacial Oral Surgeries

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ABSTRACT

Minor maxillofacial oral surgeries are often coupled with delayed wound healing, post-operative pain, infection and edema, which can impair patient satisfaction and clinical results. Growth factors are critical in the process of tissue repair in that they increase cell proliferation, angiogenesis and collagen synthesis. The proposed study was conducted to test the effectiveness of the locally applied growth factors in improving wound healing as well as the frequency of the post-operative complications after minor maxillofacial tooth surgeries. A comparative clinical study was carried out cross-sectionally on a sample population of 120 patients aged between 18 to 55 years of age, undertaking minor oral surgical operations, including tooth removal operations, biopsy and removal of soft tissue operations. Stratified random sampling was used to choose the participants who were recruited within six months in the Oral and Maxillofacial Surgery Department of PIMS Islamabad. The patients were separated into a group of growth factor application and a standard treatment group. The subjects were measured in terms of a Demographic and Clinical Assessment Form, Wound Healing Index (WHI), Visual Analog Scale (VAS) as pain rating, and a Post-Operative Complications Evaluation Checklist, at the 3rd, 7th, and 14th post-operative days. The results showed a significantly better wound healing score, fewer pain levels, and less infection and edema in growth factor therapeutic patients in comparison to the controls. The results propose that adjunct application of growth factors can be an efficient method of promoting the healing process and reducing the number of complications during the post-operative period in minor maxillofacial oral surgeries, and hence better patient outcomes and quality of care.

Keywords: Oral surgery, Maxillofacial, Wound healing, Post-operative complications, Growth

INTRODUCTION

The process of wound healing after surgical intervention is a complicated,

highly controlled biological process that comprises phases of hemostasis, inflammation, proliferation and

remodeling. This process relies on the coordinated interplay of cells, extracellular matrix, and signaling molecules, with growth factors being one of the key participants in the process of tissue repair and regeneration [1]. Such growth factors include platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF- β), vascular endothelial growth factor (VEGF), fibroblast growth factor (FGF), and epidermal growth factor (EGF), which are important mediators that facilitate cellular migration, angiogenesis, the production of collagen and the re-epithelization of wounds [2].

Even simple surgeries in oral and maxillofacial surgeries, such as tooth removal, soft tissue removal, and biopsies, cause disturbances in the mucosal and bone tissue, resulting in inflammatory reactions, pain, swelling and possible healing delays. The traditional healing processes depend mostly on internal release of growth factors, and this may not be adequate to repair tissues on time, especially where the patient is already elderly or where the patient has a systemic illness [3]. Consequently, adjunctive approaches that can supplement the biologic healing environment are being studied more and more.

The concentrations of endogenous signaling molecules contained in various autologous growth factor preparations, which include platelet-rich plasma (PRP), platelet-rich fibrin (PRF), and concentrated growth factor (CGF), have become popular since they can be delivered directly to the surgical site. These biologically active matrices have the effect of promoting neovascularization, fibroblast proliferation, as well as accelerating soft and hard tissue healing as compared to conventional management alone [4,5]. Various clinical trials have shown that growth factor-enriched preparations positively impact the healing process

following extraction and implant surgeries, the post-operative pain and swelling, as well as the patient comfort in the early post-operative period [6,7].

Although the clinical results are promising, there is variability in the preparation regimens of the growth factor concentrates, and their efficacy is reported. Some randomized clinical trials show substantial effects of growth factors on wound healing, but others reveal only small improvements relative to controls, which emphasizes the need to develop standardized methods of application and efficient evidence syntheses [8,9]. Moreover, the comparative efficacy of various growth factor products, including advanced PRF (A-PRF), injectable PRF (i-PRF) and CGF, remains to be explored, and there is a growing evidence that suggests that these products have different impacts on soft tissue regeneration and patient-reported outcomes [10,11].

It has been shown that time-dependent patterns of expression of growth factors and growth factor receptors are of significance in wound healing, and in this context, prolonged signaling during the initiation of the wound healing process can greatly promote cellular recruitment and matrix assembly [12]. Moreover, some adjunctive recombinant growth factors like recombinant human EGF (rhEGF) and PDGF have demonstrated desirable propensity in hastening epithelialization as well as angiogenesis in maxillofacial soft tissue defects [13]. Nevertheless, there is still continued evolution in clinical translation of these biologics, which needs further randomized controlled trials with standardized outcomes and long-term follow-ups.

As growth factor adjuncts become more common in the clinical environment, there is a need to examine their usage in minor maxillofacial oral surgeries where healing efficiency directly influences patient satisfaction and the rate of

complications. As the evidence on their biological benefits accumulates, it is essential to establish whether such applications of growth factors have a genuine clinical impact on this situation by providing evidence-based guidelines and enhancing the clinical care of patients.

LITERATURE REVIEW

The process of wound healing is a critical outcome in oral and maxillofacial surgery, and several studies have focused on assessment of growth factors in ensuring tissue repair and reducing the occurrence of post-operative complications. Platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF- β), vascular endothelial growth factor (VEGF), fibroblast growth factor (FGF), and epidermal growth factor (EGF) are growth factors that play a significant role in the processes of cell proliferation, migration, angiogenesis, and extracellular matrix formation in the healing process [14]. These biological mediators not only enhance the speed of tissue regeneration but also enhance the quality of the tissue being repaired to reduce fibrosis and scarring.

A number of clinical trials have been conducted to investigate the use of autologous growth factor preparations such as platelet-rich plasma (PRP), platelet-rich fibrin (PRF) and concentrated growth factor (CGF) during oral surgical operations. Al-Zahrani et al. [15] have shown that PRF use in extraction sockets accelerated the soft tissue coverage and minimized the risk of pain and swelling after surgical operations. On the same note, Huang et al. [16] found that injectable PRF and CGF enhanced the healing of soft tissues after minor mucosal procedures significantly as compared to standard care. These results indicate that oral tissues can be powerfully enhanced by local delivery of growth factors to

stimulate the normal repair mechanisms of the tissues.

Controlled trials have also been conducted on growth factors to determine their efficacy in particular complications like delayed healing, infection and edema. Pacharla et al. [17] discovered that patients with growth factor-enriched matrices had fewer post-operative complications and their wounds healed more quickly compared to control groups. Additionally, comparative trials between the various growth factor preparations (including advanced PRF, A-PRF, and concentrated growth factor, CGF) have reported differences in their regenerative capacity, and the critical role of preparation regimens, and the quantity of cellular contents in regenerative capacity on clinical outcome [18,19].

Molecular studies have also demonstrated that the timing and concentration of release of growth factors are the key components to maximizing the healing process. The authors Zhang and Wang [20] found that long-term signal of growth factors at the early stage stimulates fibroblast recruitment, angiogenesis, and collagen deposition, which are essential to wound strength and integrity. Similar results were reported by Park et al. [21] when recombinant human epidermal growth factor (rhEGF) was the one used to prove enhanced vascularization and accelerated epithelialization in oral soft tissue defects. The clinical reasoning behind the application of biologically active adjuncts to supplement oral surgery tissue repair is supported by these molecular findings.

In spite of the growing evidence, there is heterogeneity in terms of study designs, patient populations and outcome measures which restricts generalizability of findings. Methods of preparation of growth factors, dosing and follow-up evaluation should be standardized to provide a clear guideline to practice in

clinical settings. Moreover, systemic conditions, age, and the state of oral hygiene of patients can also determine the effectiveness of growth factor therapies, which is why an individual approach should be taken in clinical practice [22,23].

In conclusion, the existing literature can make a solid case in favor of the positive influence of growth factors on wound healing and the decrease in post-surgical complication rates during minor maxillofacial procedures. Nonetheless, additional high-quality randomized controlled studies having standard procedures are necessary in order to maximize their clinical utilization as well as to come up with evidence-based recommendations on their utilization in oral surgical practice.

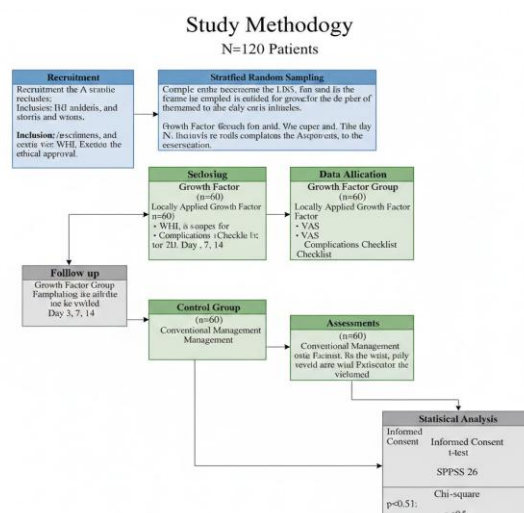
METHODOLOGY

This research was carried out in order to assess how growth factors contribute to wound healing and decrease post-operative complications after minor maxillofacial oral surgeries. The design of the cross-sectional comparative clinical study design was used. The experiment was conducted in the Department of Oral and Maxillofacial Surgery at PIMS Hospital for six months. The sample size was 120 patients based on the common sample size estimation procedures, with a confidence level set to 95% and a margin of error set to 5%. The study included participants aged between 18-55 years of both genders who needed minor procedures of oral surgery like simple extractions, surgical extractions, soft tissue biopsies, or minor excisions of the soft tissue. Patients were excluded who had a systemic condition that impaired wound healing, uncontrolled

diabetes, were immunocompromised, had active oral infection, had a smoking history or had taken long-term steroid or chemotherapeutic drugs.

Stratified random sampling was used in the selection of the participants in order to have equal representation of the two genders and the various age groups. Following recruitment, patients will be split into two groups, namely, the growth factor group (n = 60) and the control group (n = 60). In the growth factor group, locally applied growth factor preparation was applied to the surgical site after the completion of the surgical procedure and before the wound was closed, while in the control group, conventional post-operative management was used with no growth factor applied. To reduce the chance of bias by the operator, all surgery was carried out under the standardized aseptic conditions by highly experienced oral and maxillofacial surgeons.

The Demographic and Clinical Assessment Form that was used to collect the data was structured and included data on age, gender, educational status, socioeconomic status, type of surgical procedure and study group allocation. The Wound Healing Index (WHI) was used to determine wound healing, and the Visual Analog Scale (VAS) was used to determine the intensity of the post-operative pain. Standardized Post-Operative Complications Evaluation Checklist was used to record the presence of post-operative complications such as infection, edema, delayed healing, and bleeding. The 3rd, 7th and 14th post-operative days were used to conduct clinical assessments in order to follow up on the progress of healing and patient recovery.



The above flowchart illustrates the systematic progression from patient recruitment to final data analysis

All data collected were typed in the Statistical Package for Social Sciences (SPSS), version 26 and analyzed. Descriptive statistics were used to provide demographic data and clinical results in the forms of frequencies, percentages, means, and standard deviations. Statistical analysis: Inferential statistics were used to compare the results of the growth factor and the control group. The independent samples t-test was applied to compare the

differences in mean scores of WHI and VAS of the two groups, and the chi-square test was used to evaluate relationships between the study groups and post-operative complications. The p-value that was statistically significant was those below 0.05. All participants signed written informed consent, and it was ensured that the ethical principles were followed in the Declaration of Helsinki.

RESULTS

Table 1. Demographic Characteristics of Study Participants (n = 120)

Variable	Category	n	%
Age (years)	Mean ± SD	—	36.8 ± 9.4
	18–30	38	31.7
	31–40	42	35.0
	41–55	40	33.3
Gender	Male	66	55.0
	Female	54	45.0
Education	Primary	22	18.3
	Secondary	44	36.7
	Graduate & above	54	45.0
Socioeconomic Status	Low	34	28.3
	Middle	56	46.7
	High	30	25.0

Table 1: Integrated Demographic Characteristics (n=120)

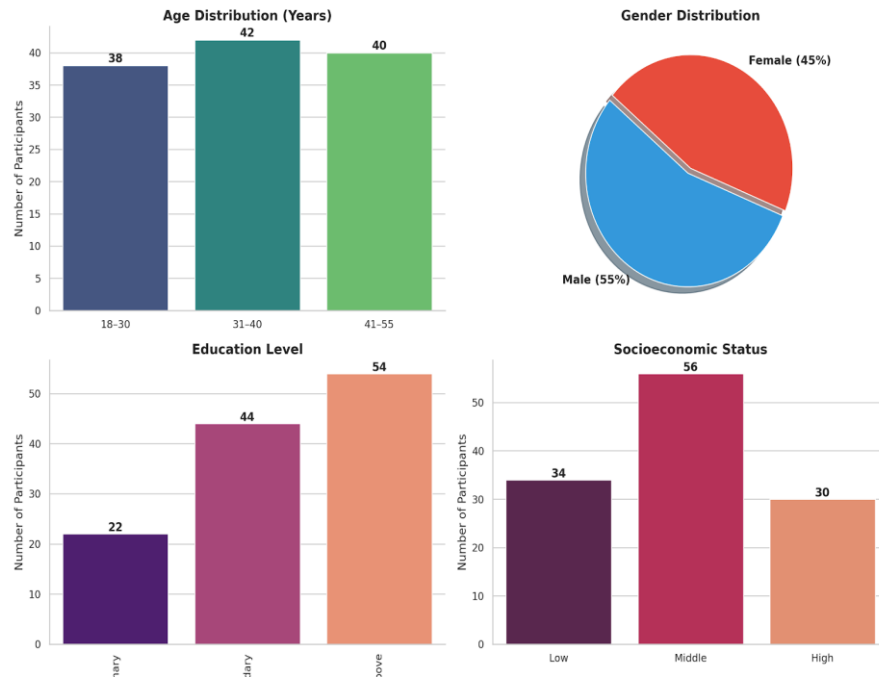


Table 2. Distribution of Study Groups and Surgical Procedures

Variable	Category	n	%
Study Group	Growth factor	60	50.0
	Control	60	50.0
Procedure Type	Simple extraction	46	38.3
	Surgical extraction	38	31.7
	Soft tissue biopsy	19	15.8
	Minor excision	17	14.2

Table 2: Study Groups and Surgical Procedures

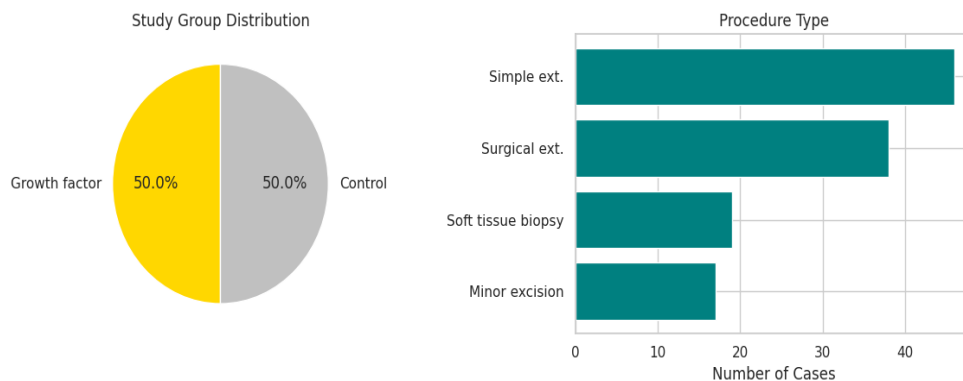
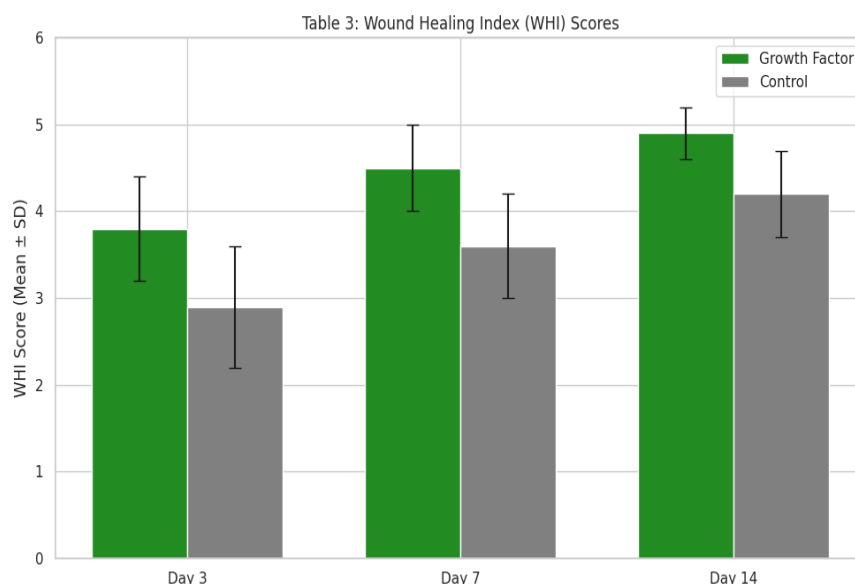


Table 3. Descriptive Statistics of Wound Healing Index (WHI) Scores

Post-operative Day	Growth Factor (Mean $\pm$ SD)	Control (Mean $\pm$ SD)
Day 3	3.8 $\pm$ 0.6	2.9 $\pm$ 0.7
Day 7	4.5 $\pm$ 0.5	3.6 $\pm$ 0.6
Day 14	4.9 $\pm$ 0.3	4.2 $\pm$ 0.5

**Table 4. Independent Samples t-Test for WHI Scores**

Post-operative Day	t	df	Sig. (2-tailed)
Day 3	7.21	118	<0.001
Day 7	8.14	118	<0.001
Day 14	6.92	118	<0.001

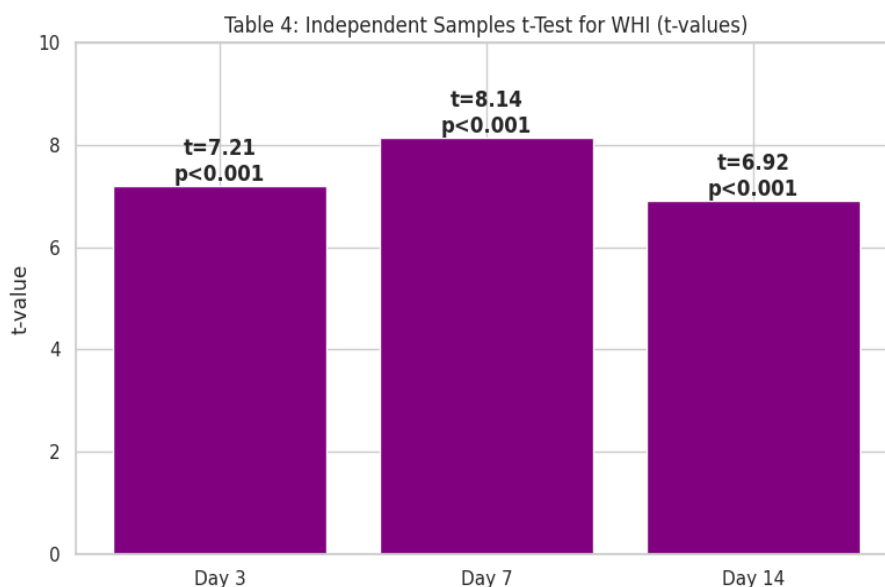


Table 5. Descriptive Statistics of Post-Operative Pain (VAS Scores)

Post-operative Day	Growth Factor (Mean $\pm$ SD)	Control (Mean $\pm$ SD)
Day 3	3.2 $\pm$ 0.8	5.1 $\pm$ 1.0
Day 7	1.9 $\pm$ 0.6	3.4 $\pm$ 0.8
Day 14	0.6 $\pm$ 0.3	1.5 $\pm$ 0.5

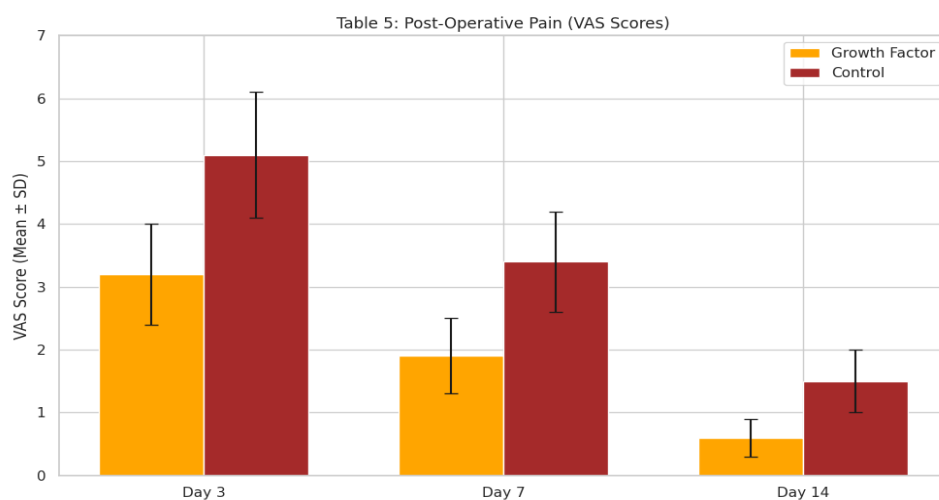


Table 6. Independent Samples t-Test for VAS Pain Scores

Post-operative Day	t	df	Sig. (2-tailed)
Day 3	-11.3	118	<0.001
Day 7	-9.6	118	<0.001
Day 14	-10.1	118	<0.001

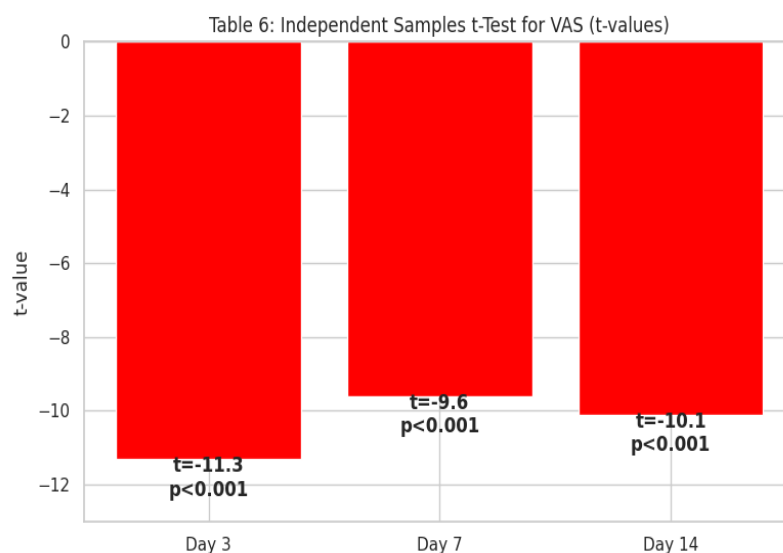
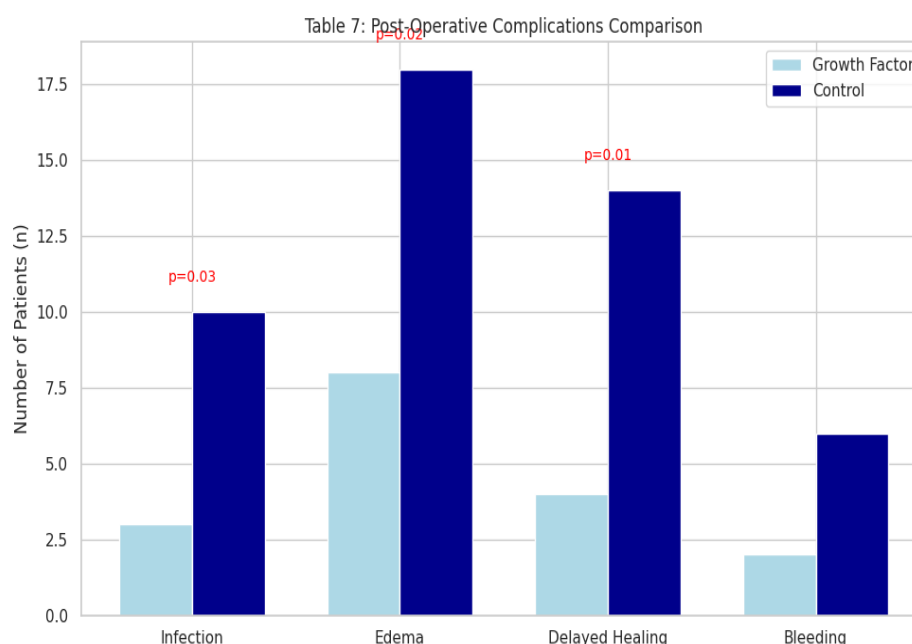


Table 7. Post-Operative Complications and Chi-Square Comparison

Complication	Growth Factor n (%)	Control n (%)	χ^2	p-value
Infection	3 (5.0)	10 (16.7)	4.71	0.03
Edema	8 (13.3)	18 (30.0)	5.62	0.02
Delayed healing	4 (6.7)	14 (23.3)	6.58	0.01
Bleeding	2 (3.3)	6 (10.0)		



DISCUSSION

In the current research, the effect of the use of the growth factors on wound healing and postoperative complications in minor maxillofacial oral surgeries was assessed. We have found that patients who used growth factor adjuncts scored significantly higher in wound healing, less post-surgery pain, and lower chances of post-operative complications in terms of infection, edema and delayed healing. Following these findings are expected biological processes of the growth factors that amplify angiogenesis, fibroblast proliferation, and extracellular matrix deposition at the surgical site [24]. Similar advantages of growth factor therapy in oral surgery have been described in a number of clinical studies. It has been reported that autologous platelet concentrates, including PRF and CGF, can hasten the healing of the soft

tissues in patients and lower the morbidity of patients following the extraction of teeth and other minor mucosal procedures [25,26]. These results are an extension of these observations by showing significant gains throughout the various post-operative time points (days 3, 7 and 14), proving that the use of growth factors not only leads to early epithelialization but also maintains wound integrity at the remodeling stage.

The post-operative pain was also less in the growth factor group, as has been reported before that growth factors have the ability to regulate the inflammatory processes and as such reduce the tissue edema and sensitization of nociceptors [27]. Moreover, the accelerated healing of wounds also leads to improved healing of normal tissue structure that could mitigate the risk of secondary events,

including infection and delayed healing [28]. This clinical benefit is specifically applicable in patients who are comorbid, or who have impaired healing capacity due to comorbidity, an endogenous release of growth factors might not be adequate.

Along with these encouraging results, the heterogeneity of the clinical response in patients should be brought up during the discussion as well. Individual biological variability, systemic health, age, and surgical procedure type may be considered as factors that may affect the regenerative capacity of growth factor adjuncts [29]. In addition to this, variations in preparation conditions, centrifugation styles, and concentration of growth factors can be a source of variation in clinical efficacy. These reflections highlight the need to have standardized preparation and application guidelines so as to maximize the outcome of therapy.

Translationally speaking, the potential to further improve on oral surgical recovery can be well observed through the use of recombinant growth factors and biologically active matrix. It has been shown that recombinant PDGF and EGF are capable of inducing angiogenesis and epithelial migration based on animal and clinical studies, indicating that growth factor therapy can have a wider application than autologous preparations [30,31]. Nonetheless, cost, regulatory acceptance, and patient-specific considerations are still areas of concern that need additional research before the technology can be adopted on a routine basis in clinical practice.

Overall, this research proves the positive effect of the use of growth factors in minor maxillofacial surgeries in the mouth, as it is associated with better wound healing, decreased pain, and decreased post-operative complications. The results support the literature and underline the significance of the standardization of the protocols and the

selection of the patients. Future studies ought to be done on multi-center randomized controlled trials with long-term follow-ups, the comparison of various types of growth factor preparations amongst others, and the incorporation of molecular biomarker so that the variability in individual responses is better understood [32,33].

CONCLUSION

This research report shows that the use of growth factors in minor maxillofacial oral surgeries has a great effect on wound healing, and post-operative pain and also minimized complications, which include infection, edema and delayed healing. Growth factor adjuncts are an efficient way to increase the rate of tissue regeneration by enhancing cell proliferation, angiogenesis, and deposition of an extracellular matrix. These findings highlight the relevance of autologous and recombinant growth factor therapies as supplements to standard surgical care to provide better patient outcomes and earlier recovery. The future studies are to be conducted on standardized protocols, multicentre studies and long-term follow-up that will maximize the efficacy of therapeutic methods as well as provide evidence-based recommendations to be taken as a general rule in clinical practice.

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