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Efficacy of Collagen Resorbable Membrane after Surgical Extraction of Impacted Mandibular Third Molar

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ABSTRACT

Impacted teeth, particularly mandibular third molars, can cause complications like pain, infection, and periodontal issues in adjacent teeth. Surgical management strategies, including the use of collagen-resorbable membranes, may improve healing and minimize postoperative complications. **Objectives:** To evaluate the effectiveness of a collagen-resorbable membrane following surgical extraction of impacted mandibular third molars, focusing on pain severity, bone status, and periodontal ligament status adjacent to the second molar. **Methods:** The quasi-experimental study utilized a non-probability sampling technique for 6 months. Patients were equally divided into three groups: A (primary closure), B (secondary closure), and C (collagen membrane-based primary closure). Pain severity, bone status, and periodontal ligament status adjacent to the second molar were evaluated clinically and via post-operative radiographs postoperatively at the 2nd, 4th, 6th, and 12th weeks. **Results:** The study involved participants with an average age of 28.51 ± 7.53 years and an unequal gender distribution across all groups. Initially, Group C experienced higher moderate to severe pain levels. Group A had the longest surgery duration at 41.89 ± 14.10 minutes. By the second week of follow-up, pain significantly decreased in all groups, with no significant differences between them. By the fourth and sixth weeks, pain levels continued to decrease, with only mild pain observed in one patient each in Groups B and C. **Conclusions:**. There is no evidence to suggest that collagen resorbable membrane it is more effective than primary or secondary closure techniques

INTRODUCTION

Third molars typically emerge between 17 and 21 years of age [1, 2]. When they're obstructed by adjacent structures, they become impacted. Around 73% of European young adults are affected and this is a common developmental issue [3]. Impacted third molars often result from inadequate space in the mandible. Surgery to remove them can lead to various complications, including nerve damage, dry sockets, pain, swelling, and infection [4]. After extraction, the alveolar socket undergoes natural resorption and remodeling, reducing its size. Techniques like socket preservation and guided tissue regeneration aim to mitigate this process, using resorbable membranes to prevent unwanted tissue growth [5, 6]. Membranes, leveraging their mechanical and physiological properties, facilitate optimal bony healing by preventing soft tissue ingress in extraction sockets. Collagen, pivotal in wound healing, imbues membranes with guiding, chemotactic, and hemostatic properties, while resisting masticatory forces [7]. Kilinc et al., found that post-surgical placement of resorbable membranes after impacted lower third molar

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extraction could enhance attachment levels, probing depths, and bone fill of adjacent molars [8]. Guided tissue regeneration, a technique developed to address intraosseous defects, employs biocompatible membranes—resorbable or non-resorbable—as barriers to epithelial migration, promoting periodontal tissue repair [9]. This technique is particularly effective in managing deep periodontal pockets following surgical extraction of impacted third molars [10]. Wound closure methods in third molar surgery are debated: primary closure involves complete flap closure, while secondary closure leaves a gap for healing. Secondary closure may reduce pain and swelling, but primary closure promotes comfort and healing [11]. However, recent reviews found no significant outcome differences, prompting further research [11]. Partially erupted molars pose risks with primary closure due to flap tension. Collagen membranes aid wound healing by promoting clot stabilization, hemostasis, and fibroblast attraction [7]. Yet, research on their use post-impacted third molar removal primarily focuses on periodontal health and bone regeneration, overlooking postoperative morbidity and wound healing evaluation. Studies on resorbable collagen membrane use post-extraction have shown conflicting results [9]. The application of resorbable collagen membrane following surgical extraction of impacted mesioangular lower third molars enhances bone regeneration, improving attachment levels and bone fill distal to the lower second molar. It reduces the distal probing depth and accelerates recovery.

This study aims to evaluate the effectiveness of collagen membrane placement after surgery for partially impacted mandibular third molars.

METHODS

This quasi-experimental study utilized a non-probability sampling technique after the approval of the synopsis and was conducted at the Department of Oral and Maxillofacial Surgery, Liaquat University of Medical and Health Sciences, Jamshoro/Hyderabad from January 2020 to December 2020. A total of 87 patients were enrolled and sample size was calculated via the Epi-tools online calculator. Participants were further divided into three groups: primary closure (PC) (n=29), secondary closure (SC) (n=29), and collagen membrane-based primary closure (CMBPC) (n=29). The study included participants of both genders aged between 18 and 50 years who required surgical extraction of impacted (mesioangular) mandibular third molars. Exclusion criteria comprised patients with pericoronitis, periapical infections or lesions related to impacted third molars, traumatic occlusion or upper third molars impingement, smokers, alcoholics, and individuals with systemic diseases. The sample size was calculated to be 57 (19 per group) using Open Epi with 80% power and a 95% confidence interval, based on the mean pain score on day 3, which was 3.93 (3.72) for primary closure and 6.72 (2.22) for membrane-based primary closure from a previous study [12]. To further increase the power of the study, we included 87 available cases. Every patient who met the inclusion criteria and gave their written consent was recruited. After getting approval from the Liaquat University of Medical and Health Sciences Ethical Review Committee in Jamshoro, Pakistan (no.LUMHS/REC-819), data were collected. Patients were categorized into three groups: A (primary closure), B (secondary closure), and C (collagen membrane-based primary closure). Data, including age, gender, clinical history, and impaction diagnosis via clinical examination and orthopantomogram, were recorded. Surgery was performed by the principal investigator at the Department of Oral and Maxillofacial Surgery, Liaquat University Hospital, using local anesthesia (2% xylocaine with 1: 100,000 epinephrine). Standard incisions and flap techniques were employed, with tooth sectioning and extraction conducted as needed. Wound closure methods varied by group: Group A received interrupted sutures (3-0 vicryl), Group B underwent secondary closure with flap repositioning and suturing, and Group C received membrane-based primary closure using a resorbable collagen membrane (Lyoplant, USA). Postoperative care included antibiotics, metronidazole, nonsteroidal anti-inflammatory drugs, and mouthwash, with suture removal after 7 days. Luckily no loss to follow up was there. Patient assessment was done by pain, bone, and periodontal ligament (PDL) status distal to the second molar were assessed clinically and via post-operative radiographs at the 2nd, 4th, 6th, and 12th weeks. Pain was measured pre- and post-operatively utilizing the Wong-Baker FACES Pain Rating Scale (0-10). Periodontal status was recorded using a Williams Probe. (1) Using a Michigan "O" probe with Williams markings, the probing depth was determined. Up until a small amount of resistance is encountered, the probe tip is introduced into the gingival sulcus parallel to the tooth's long axis. (2) The gingival margin to the cement-enamel junction at the second molar's distal surface (lingual and labiolingual) was the measurement point for gingival recession. (3) Gingival recession plus probing depth was used to record attachment loss. The bone defect was measured using orthopantomograms (OPGs), with a standardized radiographic calibration technique. Measurements were taken from the crest of the alveolar bone adjacent to the second molar to the deepest point of the surgical defect. This assessment was performed immediately after surgery and at follow-up intervals to monitor bone healing over time. To evaluate the bone state (defect size and fill), measurements from pre- and post-periapical radiographs were taken using a ruler and documented on a preform to show the healing process and bone regeneration. The data were analyzed using SPSS version 20.0, a statistical

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software program. Mean and standard deviation were calculated for age and frequency with percentages for qualitative variables. A one-way ANOVA test was run to compare age, Pocket depth (PD), gingival recession and attachment loss among three interventions and the chi-square/Fisher exact test for pain at various time points. p-values were regarded as statistically significant if they were less than 0.05.

RESULTS

A total 87 number of patients were enrolled which were divided equally into three groups named A, B and C respectively. The mean age of patients in the primary closure group was 27.03 ± 4.66 years, in the secondary closure group it was 30.03 ± 9.24 years, and in the collagen membrane-based primary closure group, it was 28.48 ± 7.92 years. The overall mean age across all groups was 28.51 ± 7.53 years. However, there was no statistically significant difference in the mean age among the patients across the study groups (p=0.321) (Table 1).

Table 1: Descriptive Statistics of the Age of Study Groups (n=87)

Variables	Age (yrs)				p-value*
	n	Mean ± SD	Minimum	Maximum	
Primary Closure	29	27.03 + 4.66 Years	18 Years	40 Years	
Secondary Closure	29	30.03 + 9.24 Years	18 Years	55 Years	0.321
Collagen Membrane -Based Primary Closure	29	28.48 + 7.92 Years	18 Years	47 Years	

*ANOVA test

Pre-operative pain assessment showed no significant differences among groups (p=0.581). In Group A, 4 (13.8%) reported "No Hurt," 10 (34.5%) "Hurts a Little Bit," and 10 (34.5%) "Hurts a Little More." Group C had more participants, 13 (44.8%), in "Hurts a Little More." By the second postoperative week, pain reduced significantly across groups (p=0.400). "No Hurt" was reported by 19 (65.5%) in Group A, 16 (57.1%) in Group B, and 12 (42.9%) in Group C. By the fourth and sixth weeks, nearly all reported "No Hurt," except 1 (3.4%) in Groups B and C (p=0.599). By the twelfth week, all participants were pain-free (p=1.000). (Table 2).

Table 2: Pre and Post-Operative Pain Assessment

Assessments	Study Groups	Levene's Test for Equality of Variances						
		No Hurt	Hurts Little Bit	Hurts Little More	Hurts Even More	Hurts Whole Lot	Total	p-value
Pre-Operative Pain	A	4 (13.8%)	10 (34.5%)	10 (34.5%)	4 (13.8%)	1 (3.4%)	29 (100%)	0.581
	B	4 (13.8%)	8 (27.6%)	9 (31.0%)	6 (20.7%)	2 (6.9%)	29 (100%)	
	C	0	7 (24.1%)	13 (44.8%)	7 (24.1%)	2 (6.9%)	29 (100%)	
Post-Operative Pain 2nd Week	A	19 (65.5%)	10 (34.5%)	0	0	-	29 (100%)	0.400
	B	16 (57.1%)	12 (42.9%)	1 (3.4%)	0	-	29 (100%)	
	C	12 (42.9%)	16 (57.1%)	1 (3.4%)	0	-	29 (100%)	
Post-Operative Pain 4th Week	A	29 (100%)	0	0	0	-	29 (100%)	0.599
	B	28 (96.6%)	1 (3.4%)	0	0	-	29 (100%)	
	C	28 (96.6%)	1 (3.4%)	0	0	-	29 (100%)	
Post-Operative Pain 6th Week	A	29 (100%)	0	0	0	-	29 (100%)	0.599
	B	28 (96.6%)	1 (3.4%)	0	0	-	29 (100%)	
	C	28 (96.6%)	1 (3.4%)	0	0	-	29 (100%)	
Post-Operative Pain 12th Week	A	29 (100%)	0	0	0	-	29 (100%)	1.000
	B	29 (100%)	0	0	0	-	29 (100%)	
	C	29 (100%)	0	0	0	-	29 (100%)	

Further results show the average probing depth was 5.41 ± 1.82 in Group A, 5.41 ± 1.82 in Group B, and 6.17 ± 1.33 in Group C (p=0.157). The mean gingival recession was 3.79 ± 1.83 in Group A, 2.96 ± 1.42 in Group B, and 3.48 ± 1.37 in Group C (p=0.132). Average attachment loss was 9.20 ± 3.02 in Group A, 8.58 ± 2.21 in Group B, and 9.65 ± 2.31 in Group C (p=0.281). However, these findings were statistically insignificant across study groups (Table 3).

Table 3: PDL Status Distal to 2nd Molar According to Study Groups (n=87)

Variables		Statistics		p-value
		n	Mean + SD	
Probing Depth (PD)	Primary Closure	29	05.41 ±1.82	0.157
	Secondary Closure	29	05.62 ± 1.39	
	Collagen Membrane-Based Primary Closure	29	6.17 + 1.33	

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Gingival Recession (GR)	Primary Closure	29	03.79 + 1.83	0.132
	Secondary Closure	29	02.96 + 1.42	
	Collagen Membrane-Based Primary Closure	29	03.48 + 1.37	
Attachment Loss	Primary Closure	29	09.20 + 3.02	0.281
	Secondary Closure	29	08.58 + 2.21	
	Collagen Membrane-Based Primary Closure	29	09.65 + 2.31	

Findings show the mean duration of surgery was 41.89 ± 14.10 minutes in Group A, 36.20 ± 12.07 minutes in Group B, and 31.89 ± 9.00 minutes in Group C, with a significantly lower duration observed in Group C (p=0.008). Surgery duration differed significantly among the groups(p=0.008). The longest mean duration was observed in the Primary Closure group at 41.89 ± 14.10 minutes (range: 18–75 minutes), followed by the Secondary Closure group at 36.20 ± 12.07 minutes(range: 21–60 minutes). The shortest mean duration was in the Collagen Membrane-Based Primary Closure group at 31.89 ± 9.00 minutes (range: 25–50 minutes).(Table 4).

Table 4: Descriptive Statistics of Surgery Duration According to Study Groups(n=87)

Study Groups	Statistics				p-value
	n	Mean ± SD	Minimum	Maximum	
Primary Closure	29	41.89 + 14.10 minutes	18 minutes	75 minutes	0.008
Secondary Closure	29	36.20 + 12.07 minutes	21 minutes	60 minutes	
Collagen Membrane -Based Primary Closure	29	31.89 + 9.00 minutes	25 minutes	50 minutes	

Further findings clearly show the bone defect was early normalized in Group C as compared to Groups A and B, while results were statistically insignificant, p-values were quite insignificant(p=>0.05)(Table 5).

Table 5: Descriptive statistics of post-operative bone defect after immediate post-operative to 12th week according to study groups(n=87)

Post-Operative Bone Defect	Study Groups	Statistics		p-value
		n	Mean ± SD	
Immediately After Surgery	Group A	29	9.62 + 4.78mm	0.419
	Group B	29	18.48 + 4.97mm	
	Group C	29	16.89 + 2.80mm	
After 2nd Week	Group A	29	16.44 + 5.07mm	0.961
	Group B	29	14.58 + 3.60mm	
	Group C	29	14.74 + 2.78mm	
After 4th Week	Group A	29	11.67 + 22.91mm	0.573
	Group B	29	9.50 + 3.79mm	
	Group C	29	5.67 + 2.24mm	
After 6th Week	Group A	29	2.32 + 0.45mm	0.296
	Group B	29	02.11 + 0.32mm	
	Group C	29	01.03 + 0.41mm	
After 12th Week	Group A	29	1.37 + 0.04mm	0.082
	Group B	29	01.39 + 0.09mm	
	Group C	29	0.44 + 0.33 mm	

DISCUSSION

Mandibular third molar (3M) surgery often results in postoperative complications such as pain, swelling, trismus, and periodontal destruction in adjacent second molars [1, 2]. Techniques to categorize tooth impaction commonly consider factors like the degree of impaction, angulation, and the molar's position relative to the anterior boundary of the mandibular ramus [13]. Factors contributing to impaction include crowding, ectopic tooth germ location, extra teeth, hereditary susceptibility, and soft tissue or bone lesions [14, 15]. Impacted third molars are frequently associated with conditions such as pericoronitis, incisor crowding, resorption of adjacent tooth roots, and temporomandibular joint dysfunction [16]. This study observed mean ages for the primary closure group was little higher than secondary closure group with no significant differences across groups (p=0.321). Similarly, gender distribution was comparable across groups (p=0.723). Postoperative assessments of probing depth, gingival recession, and attachment loss also revealed no statistically significant differences). These findings align partially with Camps-Font *et al.* [17], who reported significant gains in clinical attachment level(CAL) and reductions in probing depth, highlighting potential differences in study methodologies, sample characteristics, or follow-up durations. Postoperative pain reductions across all groups, with the collagen membrane-based group showing a slight advantage by the second week, though the differences were not statistically significant (p=0.400). This finding is consistent with Kilinc *et al.* [9], who also observed no significant pain differences among groups over a 7-week follow-up period. The similarity may stem from comparable surgical techniques or pain management protocols. However, Jim-Charm Kim [21] emphasized that collagen membrane placement after third molar extraction effectively reduced early-stage postoperative complications and enhanced gingival and periodontal repair.The difference could be due to variations in membrane properties, surgical skills, or postoperative care strategies. These findings underscore the potential benefits of collagen membranes in managing postoperative pain and promoting soft tissue healing. Surgery duration, was significantly shorter in the collagen membrane group compared to primary and secondary closure methods (p=0.008). The shorter operative time in the collagen membrane group might be attributed to its ease of application and reduced surgical manipulation. Differences in operator experience and procedural protocols could also contribute to this variation. These

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findings align with Aimetti *et al.*[18], who reported significant bone gain with membrane placement, and Sammartino *et al.*[19], who demonstrated effective healing outcomes with collagen membranes combined with platelet-rich plasma.The efficiency of collagen membranes in promoting faster wound healing and reducing surgical complexity is evident from these studies. Periodontal outcomes, with statistically insignificant differences in probing depth, gingival recession, and attachment loss across groups. Korkmaz *et al.* [20] similarly reported no significant changes in periodontal pocket depth around second molars in either primary or secondary closure groups at the three-month follow-up. The lack of significant findings in this study might result from shorter follow-up durations or the absence of advanced adjunctive techniques. However, Aimetti *et al.* [18] and Sammartino *et al.* [19] emphasized significant bone gain and periodontal improvements with membrane-based techniques,suggesting that longer follow-up durations or different patient populations might yield more pronounced differences. Differences in patient oral hygiene, surgical protocols, or membrane properties might also account for the contrasting results.

CONCLUSIONS

While the use of a collagen-resorbable membrane following the surgical extraction of impacted mandibular third molars was associated with reduced severe pain, shorter surgery duration, and improved healing with prevention of periodontal defects, there is no evidence to suggest that it is more effective than primary or secondary closure techniques. The results indicate that the collagen-resorbable membrane offers similar outcomes to traditional closure methods.

Authors Contribution

Conceptualization: RI
Methodology: RI, MO, SKP, TA
Formal analysis: MAS
Writing review and editing: MAC

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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