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Comparative Assessment of Wound Healing Between Incisions Closed with Conventional 3-0 Silk Suture and 3-0 Silk Suture Coated with 0.2% Chlorhexidine Gel – An in Vivo Randomized Controlled Trial

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Abstract:

- ***Aim:***

To compare wound healing following third molar extraction using conventional 3-0 silk sutures and 3-0 silk sutures coated with 0.2% chlorhexidine gel.

- ***Materials and methods:***

It is randomized, double-blinded, parallel-group clinical trial included 54 healthy patients aged between 20–40 years undergoing surgical removal of mandibular third molars. Participants were randomly allocated into two groups: Group A 0.2% chlorhexidine gel -coated 3-0 silk sutures and Group B 3-0 silk sutures. Wound healing was assessed using Landry's wound healing index on postoperative days 1, 3, and 7. Post operative pain and swelling were evaluated as secondary outcomes.

- ***Results:***

Group 'A', demonstrated superior wound healing scores compared to Group 'B', at all assessment intervals. The chlorhexidine-coated sutures showed better early healing response and improved tissue adaptation.

- ***Conclusion:***

Silk sutures coated with 0.2% chlorhexidine gel enhance postoperative wound healing following third molar surgery. Their use may be recommended as an effective alternative to conventional uncoated silk sutures in oral surgical procedures, given the factual data of preexisting oral microbial flora.

Keywords: *Chlorhexidine, Silk Suture, Wound Healing, Third Molar Surgery, Antimicrobial Sutures, Mandible, Incision, Post-Operative Healing, Impaction, Prognosis, Oral Surgery.*

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I. INTRODUCTION

Wound healing is a complex and dynamic biological process that involves a sequence of overlapping phases including hemostasis, inflammation, proliferation, and remodeling. After surgical third molar extraction, these stages work together to restore the function and integrity of damaged tissues. Optimal wound healing is crucial for reducing postoperative complications, especially in the surgical extraction of impacted mandibular third molars. The type of suture material used for wound closure, tissue handling, microbial contamination, and surgical technique are some of the variables that affect the healing process[1].

During the early phases of healing, sutures are essential for preserving tissue approximation, stabilizing the wound borders, and encouraging clot retention. Because of its superior handling qualities, knot security, and affordability, silk sutures continue to be used extensively in oral surgical procedures[2]. However, silk is a braided natural fiber that has a tendency to harbor microorganisms and accumulate dental plaque, which may increase the risk of postoperative infection and inflammation at the surgical site[3].

The presence of saliva and a rich microbial flora in the oral cavity creates a unique environment for wound healing. Bacterial colonisation along suture tracts can promote microbial penetration into surgical wounds, thereby causing inflammation, delayed healing, and infection[4]. To address this issue, antimicrobial-coated sutures have been developed as a preventive strategy aimed at reducing bacterial adhesion and providing localized antimicrobial activity at the wound site[5].

A well-known broad-spectrum antimicrobial agent, chlorhexidine has both bactericidal and bacteriostatic properties against a variety of Gram-positive and Gram-negative pathogens. Because of its ability to reduce oral microbial load, it has been widely utilised in dentistry in a variety of formulations, including mouth rinses, gels, and varnishes[6]. The application of chlorhexidine as a coating on sutures may act as a local drug delivery system, potentially inhibiting bacterial colonization around the suture material and improving postoperative wound healing outcomes[7]. Studies demonstrated that antimicrobial agents applied locally can significantly reduce postoperative complications associated with oral surgical procedures. The intra-alveolar application of chlorhexidine gel has been reported to reduce the incidence of alveolar osteitis and postoperative discomfort following third molar surgery[8].

Antimicrobial-coated sutures have been shown to reduce bacterial adherence and surgical site infections in various surgical specialties[9]. By reducing microbial colonization around sutures can enhance tissue repair and minimize inflammatory response during the early stages of healing[10].

Although antimicrobial sutures have gained increasing attention in surgical practice, there is limited clinical evidence regarding the effectiveness of chlorhexidine gel -coated silk sutures in oral surgical procedures, particularly following mandibular third molar extraction. Therefore, this study was undertaken to compare post operative wound healing outcomes between conventional 3-0 silk sutures and 3-0 silk sutures coated with 0.2% chlorhexidine gel in patients undergoing mandibular third molar surgery.

➢ *Aim*

To compare and evaluate the effectiveness of uncoated conventional 3-0 silk sutures versus 3-0 silk sutures coated with 0.2% chlorhexidine gel in promoting wound healing and reducing post operative infection in a clinical in vivo setting following mandibular third molar extraction.

➢ *Objectives*

- To evaluate post operative wound healing outcomes for releasing incisions closed with 3-0 silk sutures coated with 0.2% chlorhexidine gel.
- To compare post-operative complication such as infection, inflammation in the allotted set of patients
- To analyse patient comfort and clinical wound healing.

II. MATERIALS AND METHODS

The study protocol was approved by the Institutional Ethics Committee (IEC/TDCH/85/2025). The trial was prospectively registered with the Clinical Trials Registry of India (CTRI/2026/01/100206). A written informed consent was obtained from all participants. A randomized, parallel-group, double-blinded, controlled clinical trial. A total of 54 patients were included and randomly allocated into two groups of 27 participants each.

➢ *Patient's Consent*

Patients were fully informed about the aim of the study, the study procedure,the potential benefits and risks of this study. Patients were given time and opportunity to inquire about the details of the study and to decide whether or not to participate. As a mandatory requirement for participation in this study, consent was obtained from the patient pre operatively.

➢ *Inclusion and Exclusion Criteria*

Inclusion criteria were patients with age group between 20 - 40 years, third molar region (unilateral class 1,2 and position A and B) (vertical and mesioangular), patient willing to participate in the study, patient posted for surgical removal of mandibular third molar. Exclusion Criteria were patients with systemic diseases affecting wound healing, allergy to chlorhexidine, infected or contaminated surgical sites, unwillingness to participate.

➢ *Randomization and Blinding*

Randomization was performed using a computer-generated randomization sequencing. Both the patient and the outcome assessor were blinded to the group allocation. Group A (Test Group): Wound closure using 3-0 silk sutures coated with 0.2% chlorhexidine gel. Group B (Control Group): Wound closure using conventional uncoated 3-0 silk sutures. The sutures were uniformly coated two hours prior to surgery.

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➢ *Surgical Procedure*

All surgical extractions were performed under local anesthesis(2% Lignocaine with adrenaline) by qualified oral and maxillofacial surgeon using a standardized technique. After extraction, the surgical site was closed using simple interrupted sutures according to group allocation. All patients received standard postoperative instructions along with prescribed antibiotics and analgesics.

➢ *Primary and Secondary Outcomes of the Study*

Clinical examinations were performed at baseline (immediately after surgery) and during the first and second postoperative recall visits on day 3 and day 7. The primary outcome measure was the assessment of soft tissue wound healing at the surgical site. Wound healing was evaluated using Landry's Wound Healing Index, which assesses tissue colour, bleeding on palpation, granulation tissue, epithelialization, and suppuration. The healing index scores range from score 1 (very poor healing) to score 5 (excellent healing). The surgical sites were examined under adequate illumination, and healing was assessed to evaluate tissue response and bleeding. The index allowed standardized comparison of healing outcomes between the 0.2% chlorhexidine gel coated suture group and the conventional silk suture group.As secondary outcome measures, postoperative pain and swelling were evaluated. Pain intensity was assessed using a visual analogue scale (VAS), where patients rated their pain on a scale from 0 to 10 at each recall visit. Postoperative swelling was clinically evaluated by visual inspection and palpation extra orally. All outcome assessments were performed by a blinded examiner to minimize observer bias.

➢ *Study Procedures*

All surgical extractions were performed under local anesthesia by experienced surgeon using a standardized technique. Prior to surgery, a detailed medical and dental history was obtained from each participant, and written informed consent was secured. Local anesthesia was administered using 2% lignocaine hydrochloride with 1:80,000 adrenaline via inferior alveolar nerve block, lingual nerve block, and long buccal nerve infiltration. Adequate anesthesia was confirmed before initiation of the surgical procedure. The surgical field was prepared and isolated using standard sterile protocols.A standard Ward's incision was placed in the mandibular third molar region using a sterile No. 15 surgical blade. A full-thickness mucoperiosteal flap was carefully elevated using a periosteal elevator to expose the underlying bone.Controlled bone removal was performed using a low-speed straight handpiece with a 703 bur under copious sterile saline irrigation. Tooth sectioning was carried out when indicated to facilitate atraumatic removal of the impacted third molar. The tooth was delivered using elevators with minimal force. Following tooth removal, the extraction socket was thoroughly irrigated with saline to remove bone debris and blood clots. The socket was examined to ensure complete removal of tooth fragments and smoothening of sharp bony edges when required. For the test group, commercially available 2% chlorhexidine gel was diluted in 1:9 ratio under aseptic conditions to obtain 0.2% chlorhexidine gel. A sterile 3-0 silk suture of 25 cm length was uniformly coated with the prepared gel two hours prior to surgery and stored in a sterile container until use.

For the control group, sterile 3-0 silk sutures (non-coated) were used. The mucoperiosteal flap was repositioned and the relieving incision was closed using simple interrupted sutures according to group allocation. Sutures were placed with minimal tension to ensure passive wound closure and optimal tissue approximation. Knot placement was standardized and positioned away from the incision line to reduce irritation.Following suturing, the surgical site was inspected for adequate hemostasis. All patients received standardized postoperative medications, including antibiotics and analgesics, and were given detailed postoperative instructions. Patients were advised to avoid mechanical trauma to the surgical site and maintain oral hygiene as instructed.Patients were recalled on postoperative day 1, day 3, and day 7 for clinical evaluation of wound healing, pain, and swelling. Sutures were removed after the final assessment.

➢ *Bias Preventing Strategy*

To enhance the internal validity of the study, participants were selected within a restricted age range of 20–40 years and only patients with similar types of mandibular third molar impactions were included. Standardized inclusion and exclusion criteria were applied to minimize variability related to systemic health status, surgical difficulty, and wound healing potential. All surgical procedures were performed by a experienced surgeon using a standardized surgical protocol to eliminate operator-related variability. Similarly, postoperative instructions, medications, and follow-up schedules were identical for both study groups to prevent performance bias. Random allocation of participants into the test and control groups was carried out using a computer-generated random sequence.

Double blinding was implemented, wherein both the participants and the outcome assessor were unaware of the group assignment, thereby reducing selection and assessment bias. To ensure adherence to follow-up visits and minimize attrition bias, recall appointments were scheduled immediately after completion of the surgical procedure. Participants were provided with appointment details and were reminded of follow-up visits. In cases of missed appointments, patients were contacted telephonically to reschedule at the earliest possible time. Outcome assessments were carried out by a blinded investigator using standardized clinical indices at predetermined postoperative intervals (day 1, day 3, and day 7). Any participant who failed to attend follow-up visits despite repeated contact attempts was excluded from the final analysis, and group allocation was documented for transparency.

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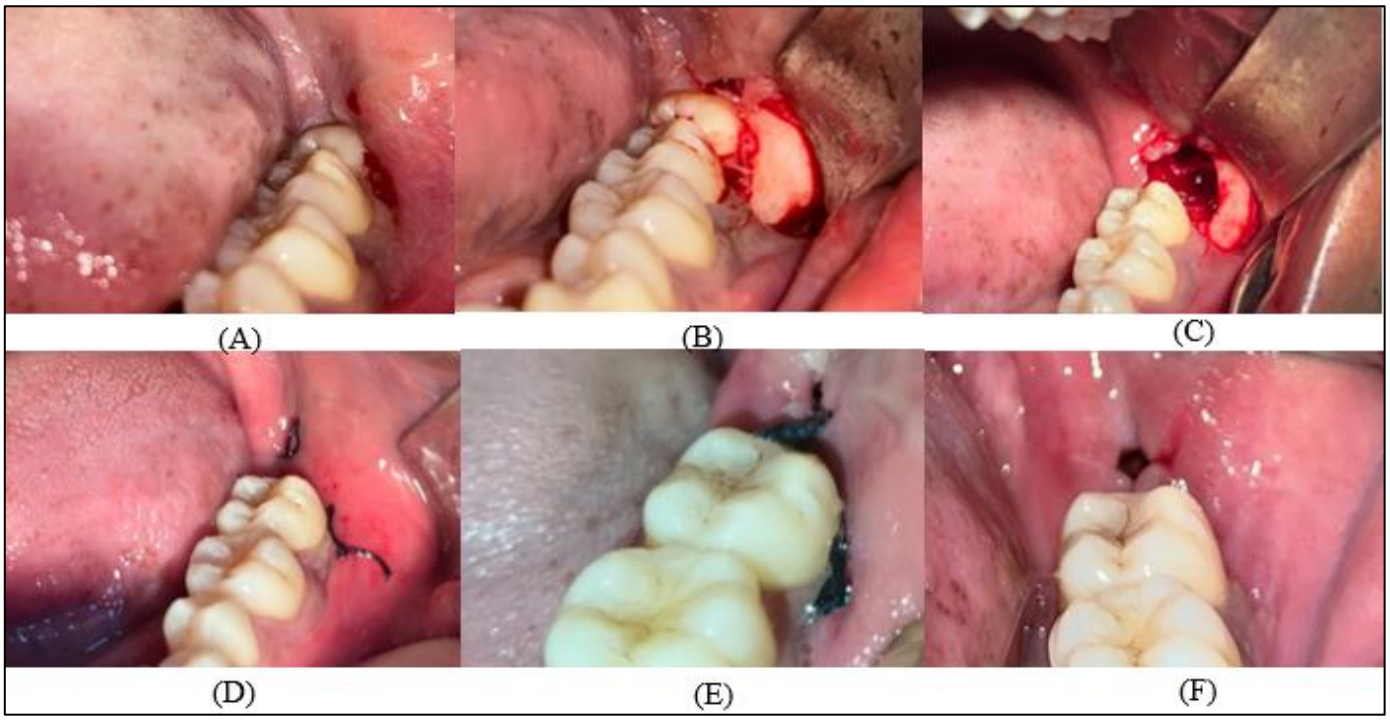

Fig 1 (A)Preoperative (B)Flap elevation (C)Tooth removal (D)Suturing done (E) post operative day 3 (F) post-operative day 7

➢ *Consort 2010 Flow Diagram*

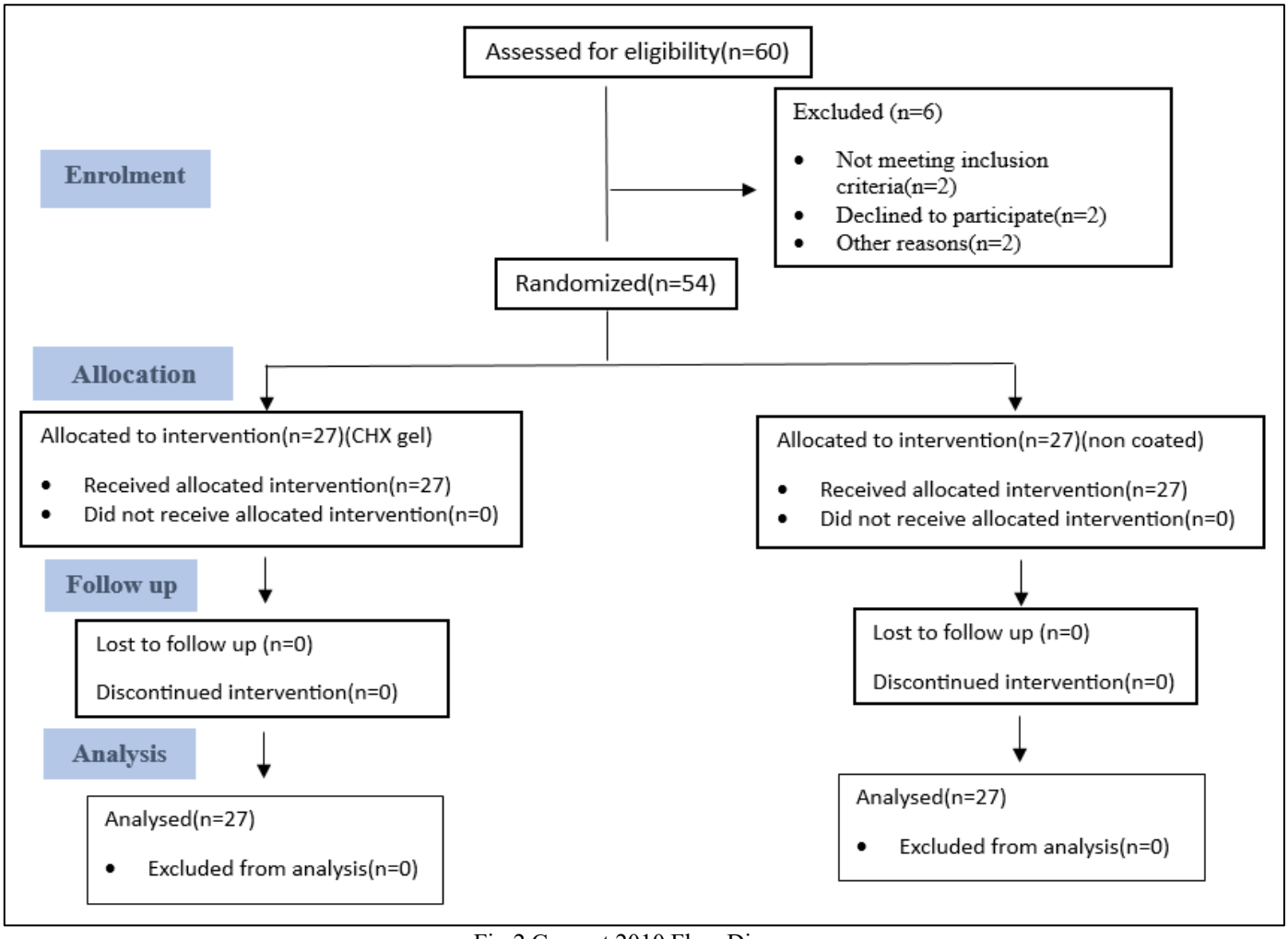

Fig 2 Consort 2010 Flow Diagram

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III. RESULT

The average age of patients was 30 years ± 6 in both groups. The phases of parallel RCT are shown in the Consolidated Standards of Reporting Trials (CONSORT) flow diagram (Fig. 1). Both groups had a similar gender distribution, no history of disease or allergies and they presented no differences with regard to hygiene measures, dietary habits or toxicological behaviour. Mean extraction time was 20 minutes +/– 3.45 being done by a single qualified and experienced maxillofacial surgeon. The difficulty index did not differ between the two groups. There is no mouth opening restriction in both groups.

No significant differences were found. There was no significant difference in swelling and postoperative symptoms between the two groups. There was a small reduction in swelling of the EG over the first few days following surgery but this was not statistically significant. The mouth opening limitation or facial swelling (the level of inflammation) at the course follow-up examinations were not significantly different between groups. The comparison of healing scores between the groups can be seen in Table 1.

Table 1: Comparison of Healing Scores Between Group A and Group B at Postoperative Days 3 and 7

Postoperative Day	Group	Mean	Standard Deviation	p value
Day 3	Group A	1.96	0.19	0.738
	Group B	2	0.54	
Day 7	Group A	4	0.21	<0.001*
	Group B	3	0.32	

Mann–Whitney U test was applied for intergroup comparison.
p value <0.05 was considered statistically significant.

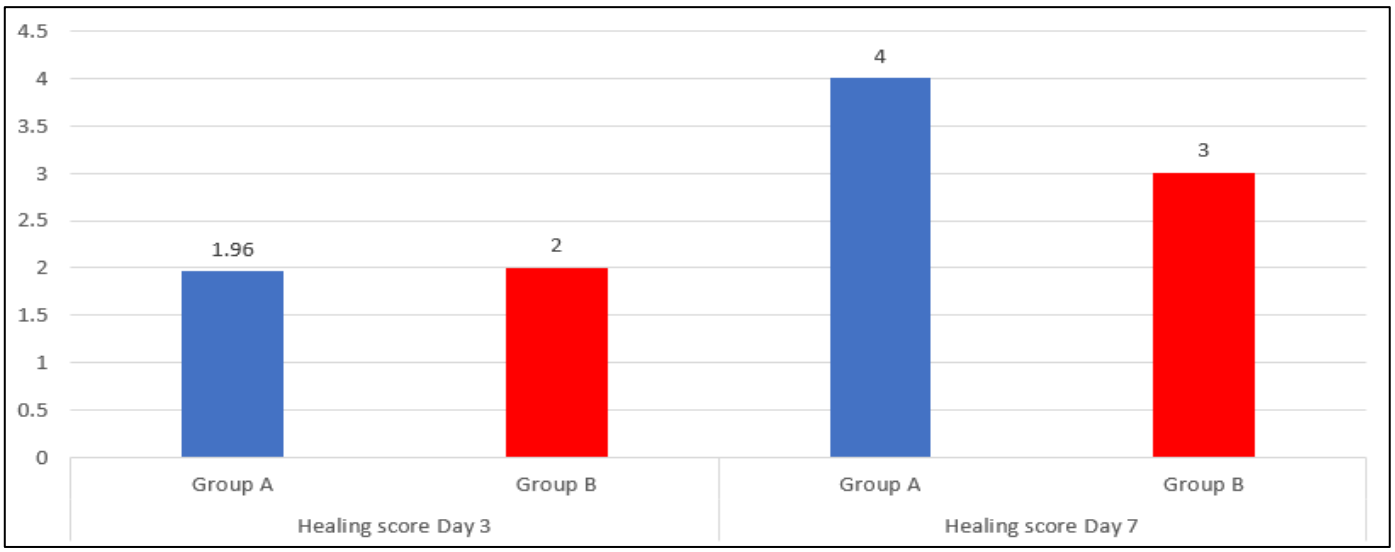

Fig 3 No significant difference between Group A and Group B regarding healing at postoperative day 3. Group A's healing scores were significantly higher than Group B on postoperative day 7.

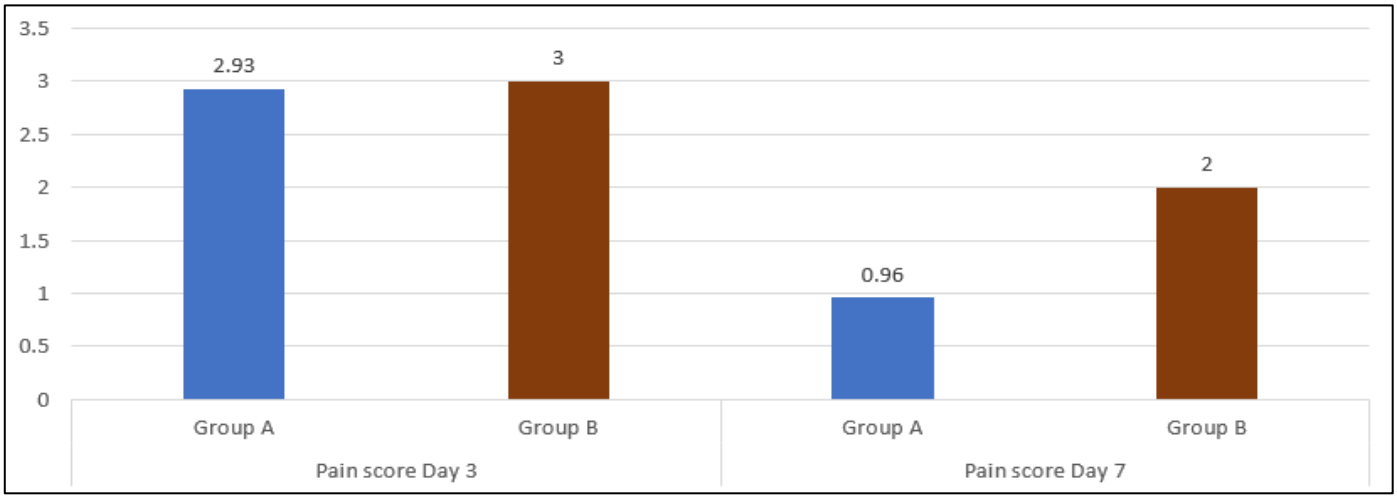

Fig 4 No significant difference was observed between Group A and Group B in pain scores on postoperative day, on postoperative day 7, Group A demonstrated significantly lower pain scores compared to Group B

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Table 2 Comparison of Pain Scores Between Group A and Group B at Postoperative Days 3 and 7

Postoperative Day	Group	Mean	Standard Deviation	p value
Day 3	Group A	2.93	0.27	0.11
	Group B	3	0	
Day 7	Group A	0.96	0.19	<0.001*
	Group B	2	0	

Mann–Whitney U test was applied for intergroup comparison.
p value <0.05 was considered statistically significant.

Comparison of Postoperative Swelling Between Group A and Group B

Table2 compares the two groups' pain scores. Group A and Group B did not differ statistically significantly on postoperative day 3 (2.93 ± 0.27 vs. 3.00 ± 0.00; p = 0.11). On the 7th postoperative day, however, Group A's pain scores were significantly lower than Group B's (0.96 ± 0.19 vs. 2.00 ± 0.00; p < 0.001).

Table 3 Postoperative Swelling Across the Groups

Postoperative Day	Swelling Status	Group A (n = 27)	Group B (n = 27)	p value
Day 1	Present	2 (7.4%)	0 (0%)	0.491
	Absent	25 (92.6%)	27 (100%)	
Day 3	Present	26 (96.3%)	27 (100%)	1
	Absent	1 (3.7%)	0 (0%)	
Day 7	Present	0 (0%)	0 (0%)	—
	Absent	27 (100%)	27 (100%)	

Chi Square Test
p-value <0.05 shows statistical significance

Table3 summarizes postoperative swelling across the groups. There was no statistically significant difference in swelling on postoperative day 1 (7.4% vs. 0%; p = 0.491) or day 3 (96.3% vs. 100%; p = 1.00). By postoperative day 7, swelling had completely resolved in both groups. Neither of the groups displayed poor healing or infectious complications of the wound throughout the postoperative period. Overall treatment tolerance was satisfactory and similar in both groups.

IV. DISCUSSION

The present randomized, double-blinded clinical trial evaluated the effectiveness of 0.2% chlorhexidine gel–coated 3-0 silk sutures compared with conventional 3-0 silk sutures in promoting wound healing following mandibular third molar extraction. The results demonstrated significantly improved wound healing and reduced postoperative pain in the test group by postoperative day 7, while no significant differences were observed during the early inflammatory phase.

➢ *Wound Healing Outcomes*

Wound healing was assessed using Landry's Wound Healing Index. As shown in Table 1, there was no statistically significant difference in healing scores between Group A and Group B on postoperative day 3 (p = 0.738). This finding suggests that during the initial inflammatory phase, healing is primarily influenced by surgical trauma, host immune response, and clot formation rather than bacterial colonization alone.

However, by postoperative day 7, Group A demonstrated significantly superior healing compared to Group B (p < 0.001). This improvement corresponds to the proliferative phase of healing, characterized by fibroblast proliferation, collagen deposition, angiogenesis, and epithelialization. The improved outcomes in the chlorhexidine-coated suture group may be attributed to reduced bacterial colonization along the suture tract, thereby minimizing prolonged inflammation and enhancing tissue maturation[1]. Similarly, Amaliya et al.[2] demonstrated enhanced early wound healing with 0.2% chlorhexidine gel application after tooth extraction. Romero-Olid et al.[3] further confirmed that chlorhexidine significantly improves postoperative wound healing in oral surgical procedures.

Silk sutures, due to their braided structure, are prone to bacterial adhesion and plaque retention. Chlorhexidine-coated sutures exhibit reduced bacterial colonization compared to non-coated sutures[4]. This reduction in microbial adherence can be explained by the modification of the suture surface characteristics. Conventional silk sutures are braided multifilament materials that create interstitial spaces, facilitating capillary action and bacterial entrapment. These retained microorganisms can proliferate within the suture matrix and along the suture tract, acting as a nidus for persistent inflammation. Antibacterial-coated sutures reduce this phenomenon by either releasing antimicrobial agents or by altering the surface energy of the suture, thereby limiting bacterial attachment and biofilm formation[5]. Superior antimicrobial activity of chlorhexidine-coated sutures against periodontal pathogens, further supporting the rationale for antimicrobial suture modification. Chlorhexidine is a cationic bisbiguanide that binds electrostatically to negatively charged bacterial cell walls. At low concentrations, it exerts a bacteriostatic effect by increasing membrane permeability, while at higher concentrations it becomes bactericidal by

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causing cytoplasmic precipitation and irreversible membrane damage. Its property of substantivity allows it to bind to oral tissues and be released slowly over time, providing prolonged antimicrobial action at the surgical site[6].The biological basis of improved healing may also be related to chlorhexidine's ability to reduce plaque accumulation and gingival inflammation, as originally demonstrated by Löe and Schiott[10]. By limiting microbial biofilm formation, chlorhexidine facilitates faster transition from the inflammatory phase to the proliferative phase of healing[10].

Veraldi et al.[17] demonstrated the clinical efficacy of topical agents containing regenerative compounds in improving epithelial repair. However, chlorhexidine remains one of the most extensively studied and clinically validated antimicrobial agents in dentistry.

➢ *Pain Assessment*

Pain scores, presented in Table 2, revealed no statistically significant difference between the groups on postoperative day 3 ($p = 0.11$). Early postoperative pain is primarily influenced by surgical trauma, inflammatory mediator release, and tissue manipulation. However, by postoperative day 7, Group A exhibited significantly lower pain scores compared to Group B ($p < 0.001$).

This reduction in pain may be secondary to decreased bacterial contamination and inflammatory response at the surgical site. Chlorhexidine has been shown to reduce postoperative inflammatory complications. By limiting bacterial colonization, chlorhexidine reduces the production of bacterial enzymes and toxins that may contribute to fibrinolysis and clot breakdown. Additionally, its substantivity ensures sustained antimicrobial activity, thereby protecting the blood clot during the critical early healing period. As a result, the incidence of dry socket and inflammatory complications is significantly reduced[7]. 0.2% chlorhexidine gluconate either as a preoperative rinse or as a postoperative application during surgery reduced postoperative complications after the extraction of an impacted third molar. Postoperative use restricts secondary colonization of the extraction site, reducing the microbial load, reduces intraoperative contamination of the surgical wound[13].

Third molar surgery is commonly associated with postoperative complications such as pain, swelling, trismus, and infection[9]. The postoperative discomfort significantly affects patient satisfaction following third molar surgery[8]. The improved pain profile observed in the test group in the present study suggests that chlorhexidine-coated sutures may enhance postoperative patient comfort.

➢ *Postoperative Swelling*

Postoperative swelling findings are summarized in Table 3. No statistically significant difference was observed between the groups on postoperative days 1 and 3, and swelling had completely resolved by day 7 in both groups.

Swelling is primarily a result of surgical trauma and the release of inflammatory mediators rather than microbial colonization alone. Therefore, the antimicrobial effect of chlorhexidine may not significantly influence early postoperative edema[3].The biological mechanisms of tissue repair emphasize that inflammation after trauma is a necessary physiological process for appropriate wound healing rather than just a pathological response. The phases of tissue repair—hemostasis, inflammation, proliferation, and remodeling-occur in a synchronized order[18].

The present findings suggest that coating silk sutures with 0.2% chlorhexidine gel is a simple, economical, and clinically feasible modification that enhances wound healing and reduces postoperative pain. Given that silk sutures are widely used due to ease of handling and knot security, antimicrobial coating may compensate for their susceptibility to bacterial colonization.

V. CONCLUSION

In comparison to traditional uncoated silk sutures, 3-0 silk sutures coated with 0.2% chlorhexidine gel shown a notable improvement in postoperative wound healing following mandibular third molar surgery. By postoperative day 7, the chlorhexidine-coated sutures demonstrated significantly improved healing and decreased discomfort, despite the fact that no discernible differences were seen during the early inflammatory phase (day 3). Chlorhexidine's antibacterial qualities, which lessen bacterial colonization and the ensuing inflammatory response at the surgical site, are responsible for this improvement.

However, there was no significant difference in postoperative swelling between the two groups, suggesting that early edema is more likely to be caused by variables like surgical trauma. All things considered, applying chlorhexidine gel to silk sutures seems to be an easy, economical, and therapeutic change that improves patient comfort and tissue recovery. For oral surgical operations, chlorhexidine-coated sutures can therefore be suggested as a dependable substitute for traditional sutures in order to improve postoperative results.

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