

Chitosan for antimicrobial activity and wound healing in post-extraction sockets: a prospective clinical study

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Abstract

Purpose

To evaluate whether intra-socket placement and topical application of chitosan improves haemostasis, pain, soft-tissue and bone healing after routine dental extraction and its antimicrobial activity.

Methods

Sixty adults requiring routine dental extraction were randomly allocated to study ($n = 30$) and control group ($n = 30$). The intervention in the study group comprised chitosan powder mixed with saline and placed in the socket, followed by topical chitosan hydrogel; control group received gelatin sponge with topical hydrogel. Wound healing (Landry wound healing index), pain (Numerical pain rating scale), and bleeding were evaluated during the first postoperative week. Socket radiopacity scores and digital grayscale values were assessed at 5, 13, and 20 weeks. Sutures were removed on day 7 and cultured for *Streptococcus* species and *Lactobacillus* species.

Results

Wound healing showed significant difference among the groups on day 7 ($p = 0.001$). Radiopacity scores and grayscale values were higher in the chitosan group at all radiographic follow-ups (all $p < 0.001$). The pain score showed no significant difference among the study and control groups on day 1, 3 and 7. Microbiological analysis showed no growth in study group as compared to control group (168 CFU/mL of *Streptococcus* species and 15 CFU/mL of *Lactobacillus* species). No adverse effects were reported in the study.

Conclusion

The study shows effective soft-tissue healing and socket mineralization. The antimicrobial and haemostatic findings show that chitosan offers a safe and effective means of enhancing post-extraction socket healing, with potential benefits for subsequent implant or prosthetic rehabilitation.

Introduction

Tooth extraction is one of the commonly performed procedure in dentistry. However, it leaves behind an open wound in the alveolar socket that's highly vulnerable to the oral microorganisms [1]. Healing after tooth extraction depends on stable clot formation, controlled inflammation, soft-tissue closure, and progressive replacement of the socket by bone. Disruption of this sequence can lead to persistent bleeding, infection, delayed healing, and alveolar osteitis [1, 2]. Although antibiotics are sometimes prescribed, their routine use after uncomplicated extraction is controversial and contributes to avoidable

adverse effects and antimicrobial resistance [3, 4]. To mitigate such risks, the use of local intra-socket medicaments have been explored.

Various therapeutic agents, including tetracycline, hydrocortisone, lincomycin, clindamycin, chlorhexidine, and metronidazole, are employed with variable efficacy as intra-socket dressings. Although well tolerated, topical chlorhexidine may cause staining, altered taste or local irritation, while metronidazole alone has shown inconsistent effectiveness. Evidence supporting their combined intra-alveolar use is also limited, and the effect remains confined to the extraction socket [3]. Thus, a locally applied material that supports haemostasis and repair while limiting bacterial growth could be clinically useful.

Chitosan is a deacetylated derivative of chitin with cationic, biodegradable, mucoadhesive, and haemostatic properties [5]. Its positively charged amino groups interact with negatively charged erythrocytes, platelets, and bacterial cell surfaces. These interactions may promote clot formation independently of the classical coagulation cascade and may disrupt bacterial membrane integrity [6, 7]. Chitosan-based matrices can also retain exudate, provide a temporary scaffold, and support cell migration and tissue repair [8, 9]. It exhibits potent bactericidal activity against pathogenic oral bacteria like *Enterococcus faecalis*, *Staphylococcus aureus*, and *Streptococcus mutans* [6]. Chitosan shares a chemical resemblance with glycosaminoglycans (GAGs), the primary constituents of bone extracellular matrix, thereby exhibiting strong osteoconductive properties.

Dental applications of chitosan have included haemostatic dressings, antimicrobial formulations, guided bone-regeneration membranes, and socket dressings [5, 6]. With high porosity, controlled drug release capabilities, and excellent biocompatibility, Chitosan has shown promise as a material for improved socket healing and guided bone regeneration [8]. Its role in reducing oral mucositis, minimizing ulcer size, and accelerating mucosal repair further highlights its multifaceted clinical applications in oral and maxillofacial surgery [8, 9]. However, clinical evidence simultaneously examining soft-tissue healing, microbial growth, haemostasis, pain, and longitudinal radiographic changes remains limited.

The purpose of this prospective clinical study was to compare intra-socket and topical chitosan with gelatin sponge following routine dental extraction. The primary clinical objective was to assess wound healing and antimicrobial activity. Secondary objectives were to evaluate postoperative pain, haemostasis and radiographic indicators of bone healing.

Materials and methods

Study design and Participants (Fig. 1)

This single-centre prospective randomized controlled clinical study was conducted in the Department of Oral and Maxillofacial Surgery and Implantology. The protocol was approved by the Institutional Review Board (SRMDC/IRB/2023/MDS/No.404). The study was conducted in accordance with the Declaration of Helsinki and ethical approval was granted by the Institutional Ethics Committee. The study was

conducted in accordance with the CONSORT guidelines. All participants received an explanation of the study in a language they understood and provided written informed consent before enrolment.

Adults aged 20–60 years, classified as American Society of Anesthesiologists (ASA) physical status I or II, and requiring routine atraumatic extraction were eligible. Inclusion criteria included grade II mobility with stage I or II periodontal radiographic bone loss, dental caries, grossly decayed teeth, root stumps, or a need for multiple extractions. Exclusion criteria were age outside the stated range, tobacco consumption, ASA status III or IV, infection at or around the operative site, periapical pathology, and impacted or unerupted teeth.

Sample size and allocation

An a priori calculation in G*Power version 3.0 used an effect size of 0.86, one-sided alpha of 0.05, power of 95%, and a 1:1 allocation ratio, yielding 60 study units (30 per group). Eligible participants were randomly assigned to the study or control group using computer generated sequence.

Clinical procedure

All extractions performed were atraumatic and under local anaesthesia (2% Lignocaine + adrenaline in the ratio 1:80,000). After extraction, the socket was curetted but not irrigated with an antiseptic or antimicrobial agent. In the study group, chitosan fine powder (Swakit Biotech Pvt. Ltd., India) was mixed with 0.9% saline to a ball of paste and placed in the socket. The site was sutured with 3 – 0 silk and Kito-Clot chitosan haemostatic hydrogel (Swakit Biotech Pvt. Ltd.) was applied topically over the sutured socket. Kito-Clot chitosan haemostatic hydrogel was reapplied at postoperative reviews on days 1, 3, and 7 (Fig. 2). In the control group, gelatin sponge (Hemosponge) was placed in the socket before closure with the same suture material; and hydrogel was applied topically and reapplied on the same post operative review days.

Same post extraction instructions were given to all the patients in both study and control group. Systemic antibiotics were not prescribed. Anti-inflammatory medication- Tab. Zerodol P (Aceclofenac 100mg + Paracetamol 325 mg) was prescribed three times for the first 24 hours, after which rescue analgesia (Tab. Paracetamol 650mg) was prescribed as required. Sutures were removed on day 7 and sent for microbiologic culture testing.

In Vitro procedure

The removed sutures were transported to a Culture Media from BHI broth. Two bacterial strains- *Streptococci species* And *Lactobacilli species* CFU/ml was calculated. Selective media was prepared for both the bacterial strains- Blood agar plate for *Streptococci species* and ROGOSA SL Agar Himedia for *Lactobacilli species* Blood agar plate was prepared using 5% sheep blood and it was steamed at 100 degrees Celsius for 20 minutes. ROGOSA SL Agar Himedia is heated at 90 degrees Celsius for 2–3

minutes and nutrient media is prepared following the manufacturer’s instructions. Both the selective culture media was prepared and inoculated. The removed sutures were then transferred from the BHI transport media and sent for culture. Each suture from both control and study group was cut into two and sent for culture of both the bacterial strains. CFU was calculated for both study and control group for each strain (Fig. 3 & Fig. 4). Chitosan testing was done at 1:300 and 1:400 concentrations in the above mentioned medium.

Outcome assessment

The participant and assessor were blinded to the treatment provided. Pain was recorded using a Numerical Pain Rating Scale on postoperative days 1, 3, and 7. Haemostasis was recorded as bleeding present or absent immediately after the procedure (day 0) and on days 1 and 3. Soft-tissue healing was graded using the Landry healing index on days 1, 3, and 7. Radiographic healing was evaluated at 5, 13, and 20 weeks using a 0–4 ordinal radiopacity score. Digital images were also analysed in Corel Photo-Paint X3 using an 8-bit grayscale range from 0 to 255 [Table 1].

Table 1. Outcome assessment parameters

NO.	PARAMETERS AND DEFINITION	SCALE	SCORES/UNIT	REVIEW TIME (Days/Weeks)
1.	Pain (As perceived by the patient)	Numerical pain Rating Scale	No pain : 0 Mild pain : 1–3 Moderate pain : 4–6 Severe pain : 7–10	Day- 1,3&7
2.	Haemostasis	Bleeding chart	• Procedural bleeding (Day 0)- Yes/No • Early Bleeding (Day 1)- Yes/No • Delayed Bleeding (Day 3)- Yes/No	Day- 0,1&3
3.	Wound Healing	Landry's index	1- Very Poor 2- Poor 3- Good 4- Very Good 5- Excellent	Day- 1,3 &7
4.	Bone density	Gray Scale Analysis using 'Corel Photo X3 Software'	Total- 256 shades of gray Each colour- value between 0 to 255 0- Darkest (Black) 255-Lightest (White)	Week-5,13& 20
5.	Bone density by radiopacity scoring scale	Number	Nil/Failure- 0 Very minimal/doubtful- 1 Minimal- 2 Moderate- 3 Complete- 4	Week- 5,13&20.

Statistical analysis

Data were analysed in IBM SPSS Statistics for Windows, version 26. Normality was assessed using Kolmogorov-Smirnov and Shapiro-Wilk tests. Continuous outcomes were summarized using means and standard deviations and were compared between groups using independent-samples t tests. Categorical outcomes were summarized as frequencies and percentages. Statistical significance was set at $p < 0.05$.

Results

Sixty study samples were included, with 30 allocated to each group (Study and Control group). Results were reported for all 60 samples at each follow-up.

Soft-tissue healing (Table 2):

Both groups had a mean Landry score of 3.00 on day 1. Healing improved by day 3, without a significant between-group difference (mean difference 0.17, $p = 0.326$). On day 7, the study group (Fig. 1) had a higher score than the control group (4.47 [SD 0.73] versus 3.47 [SD 0.51]); the reported mean difference was 1.00 (95% CI 0.66–1.34; $p = 0.001$).

Table 2
Soft-tissue healing scores

Time	Study, mean (SD)	Control, mean (SD)	Between-group result
Day 1	3.00 (0.00)	3.00 (0.00)	Not tested/reported as identical
Day 3	3.67 (0.48)	3.50 (0.63)	MD 0.17; $p = 0.326$
Day 7	4.47 (0.73)	3.47 (0.51)	MD 1.00; 95% CI 0.66–1.34; $p = 0.001$

Pain (Table 3):

Pain decreased in both groups over the first postoperative week. No statistically significant between-group difference was reported on day 1 ($p = 0.057$), day 3 ($p = 0.276$), or day 7 ($p = 0.096$).

Table 3
Numerical pain rating scale scores

Time	Study, mean (SD)	Control, mean (SD)	p value
Day 1	7.07 (0.64)	7.37 (0.56)	0.057
Day 3	5.00 (0.69)	4.80 (0.71)	0.276
Day 7	1.43 (0.57)	1.70 (0.65)	0.096

Haemostasis:

By day 3, no bleeding was recorded in either group.

Radiographic healing (Tables 4 & 5):

Radiopacity scores were higher in the study group at 5, 13, and 20 weeks ($p < 0.001$) (Table 4). Mean grayscale values were also higher with study at every interval. The reported mean differences in grayscale value were 20.20 at 5 weeks, 24.37 at 13 weeks, and 25.80 at 20 weeks (all $p < 0.001$).

Table 4
Radiopacity score

Time	Study, mean (SD)	Control, mean (SD)	Mean difference; p value
5 weeks	1.77 (0.43)	1.00 (0.00)	0.77; $p < 0.001$
13 weeks	2.87 (0.35)	2.03 (0.18)	0.83; $p < 0.001$
20 weeks	3.90 (0.31)	3.03 (0.18)	0.87; $p < 0.001$

Table 5
Mean grayscale value of the healing socket

Time	Study, mean (SD)	Control, mean (SD)	Mean difference (95% CI); p value
5 weeks	100.80 (7.01)	80.60 (13.61)	20.20 (14.61–25.79); $p < 0.001$
13 weeks	136.50 (8.27)	112.13 (8.25)	24.37 (20.10–28.63); $p < 0.001$
20 weeks	160.40 (17.05)	134.60 (14.45)	25.80 (17.63–33.97); $p < 0.001$

Microbiological findings (Figs. 3 & 4):

The reported experiment yielded 168 CFU/mL of *Streptococcus* species and 15 CFU/mL of *Lactobacillus* species in the respective controls, with no detectable growth in chitosan-treated samples at 1:300 and 1:400 concentrations.

Discussion

Dental extractions remain a cornerstone of oral and maxillofacial surgery practice, yet they carry inherent risks that can transform a straightforward procedure into a challenging recovery for patients [10]. These interventions expose the alveolar socket to the oral environment, where complications arise in approximately 2.6% – 30% of cases [11]. Predisposing elements including age, tobacco use, female gender, tooth configuration, and surgical complexity exacerbate inflammation and impair clot stability [10]. Such setbacks not only prolong discomfort and necessitate additional interventions but also contribute to alveolar bone resorption, complicating future prosthetic rehabilitation [12].

Contemporary management, including periostomes, physics forceps, and minimal bone removal, emphasize on atraumatic techniques to preserve socket integrity [11]. For haemostasis, initial pressure

packs or resorbable agents like gelatin sponges (gelfoam) provide mechanical tamponade, proving reliable in uncomplicated cases but less so for patients on anticoagulant therapy [13]. Prevention of alveolar osteitis traditionally employs medicated dressings like zinc oxide-eugenol paste or chlorhexidine rinses, though recurrence rates can hover around 20% [14]. Infections are often addressed prophylactically with systemic amoxicillin, a practice under scrutiny due to rising antimicrobial resistance; meanwhile, edema and trismus respond to perioperative corticosteroids or NSAIDs. Sometimes, preoperative debridement and localized therapies take precedence over systemic drugs to optimize bioavailability and minimize adverse effects. The shift toward site-specific interventions reflects a broader recognition that local delivery circumvents hepatic first-pass metabolism and patient-specific variables like allergies or organ dysfunction [12].

Chitosan which is a naturally derived polysaccharide is used as a local drug. Lestari et al. affirm chitosan's value across oral and maxillofacial applications, from trauma haemostatic agents to guided bone regeneration membranes that rival synthetic alternatives without cytotoxicity [5]. It offers a compelling, multifaceted approach to these challenges when applied as an intra-socket medicament in forms such as powders, gels, or films [15]. Its positively charged amino groups enable simultaneous action across key domains: hemostasis through electrostatic attraction of negatively charged erythrocytes and platelets, forming a stable mucoadhesive seal independent of the coagulation cascade [12].

Chitosan has applications in tissue engineering and regenerative medicine. It's ECM-mimicking GAG-like backbone supports osteoblasts, chondrocytes, and neural cells—upregulating ALP/osteocalcin for bone, or collagen type II for cartilage [21]. Composites with hydroxyapatite regenerate critical-sized defects twice as fast; nerve conduits guide axonal regrowth via sulfated derivatives. In cardiovascular engineering, vascular grafts resist thrombosis via nitric oxide release; skin substitutes vascularize dermis layers [22].

Chitosan's porous structure and pH-responsive swelling make chitosan nanoparticles (CNPs) prime for sustained release. They encapsulate antibiotics, chemotherapeutics, or DNA/RNA, protecting payloads from degradation and targeting acidic tumor microenvironments or inflamed tissues [17]. Mucoadhesive films deliver vaccines nasally or buccally, boosting IgA responses as adjuvants by activating TLR-4 [18].

Chitosan's broad-spectrum antimicrobial activity is by disrupting bacterial membranes chelating essential ions, and inhibiting mRNA transcription and accelerated wound healing via fibroblast recruitment, TGF- β -mediated collagen synthesis, and a moist micro-environment that fosters epithelialization [16]. Clinical evidence underscores its efficacy in averting dry socket, with incidence reduced to near zero in treated sockets compared to 5–10% in controls, as the material stabilizes clots and excludes debris [1].

The routine prescription of systemic antibiotics after uncomplicated dental extraction remains controversial. Evidence suggests that prophylactic antibiotics are not routinely required in healthy individuals undergoing simple extractions. Overprescription contributes to antimicrobial resistance and

adverse drug reactions [19]. The present study demonstrates that local placement of chitosan provides antimicrobial protection and supports healing without reliance on systemic antibiotics in uncomplicated cases. Chitosan cannot replace systemic antibiotics in immunocompromised patients, cases with active periapical pathology, or established infection [20].

Antimicrobial Mechanism:

Chitosan's antimicrobial action is well documented. Its polycationic structure disrupts bacterial cell walls by binding to negatively-charged microbial membranes, causing intracellular substances to leak out. It also chelates essential trace elements required for bacterial growth and interferes with DNA transcription. Studies report its efficacy against common oral pathogens including *Streptococcus* species and anaerobes implicated in alveolar osteitis [24]. This antimicrobial effect may indirectly contribute to improved healing by reducing bacterial load and minimizing inflammatory delay [23]. Sez-Alcaide et al. reported a 50% drop in post-operative third molar infections, alongside diminished pain and trismus, with a chitosan-chlorhexidine formulation [6]. Gupta et al. demonstrated reduced microbial load and enhanced early osteogenesis in extraction sockets of erupted teeth using chitosan dressings [1].

Soft Tissue Healing:

Chitosan mostly acts during the proliferative phase rather than the immediate inflammatory phase of wound healing [8]. The enhanced soft tissue healing observed can be attributed to the biological properties of chitosan. Chitosan is a deacetylated derivative of chitin, possessing a positive charge due to its free amino groups. This cationic nature facilitates electrostatic interaction with negatively charged cell membranes, promoting fibroblast adhesion, migration, and proliferation. Studies have reported that chitosan enhances granulation tissue formation by stimulating growth factors such as TGF- β and PDGF. Additionally, its ability to maintain a moist wound environment supports epithelialization and collagen deposition [25]. de Jesus et al. In their study showed accelerated oral mucosal repair by 30% through cytokine modulation by chitosan [8].

Pain Assessment:

Chitosan oligosaccharides can suppress TNF- α and IL-6 production in activated macrophages. Reactive oxygen species scavenging and macrophage modulation have also been demonstrated with modified chitosan-based hydrogels, while a multicomponent chitosan-containing oral gel has been associated with reduced postoperative swelling [26]. However, postoperative pain after routine dental extraction is multifactorial and largely influenced by surgical trauma, tissue manipulation, and individual pain thresholds. The absence of significant intergroup differences suggests that while chitosan may modulate inflammation, its analgesic effect may not be strong enough to produce clinically significant differences in routine extraction cases [27].

Haemostatic Effect:

Chitosan is widely recognized for its haemostatic capability, which is independent of the classical coagulation cascade. Its positively charged surface attracts negatively charged erythrocytes and platelets, forming a stable clot through ionic interaction [28]. Chitosan promotes platelet adhesion and aggregation, forming a mechanical barrier over the wound surface [29]. For hemorrhagic risks in antithrombotic patients, Radhakrishna et al. found chitosan outperformed gauze packs, achieving hemostasis without prolonged pressure [30]. The comparable hemostasis in both groups in the present study indicates that chitosan is at least as effective as conventional gelatin sponge (gelfoam) in achieving clot stabilization without adverse effects.

Bone Regeneration and Radiographic Assessment:

The osteogenic effect of chitosan can be explained through multiple mechanisms. Chitosan acts as an osteoconductive scaffold due to its porous structure, facilitating cell infiltration and vascularization [30]. It promotes osteoblast proliferation and differentiation by enhancing alkaline phosphatase activity and expression of osteogenic markers such as osteocalcin. Experimental studies have demonstrated that chitosan-based biomaterials accelerate trabecular bone formation and mineral deposition [21, 22]. Furthermore, chitosan's biodegradability allows gradual replacement by newly formed bone, thereby supporting physiological remodeling. Radiographically, its GAG-like structure promotes osteoconduction, elevating bone density by 20%-30% within weeks via osteoblast activation and vascular ingrowth, mitigating resorption [7]. The grayscale analysis performed in this study provides quantitative evidence of bone density changes. Digital radiographic grayscale evaluation is considered a reliable method for longitudinal assessment of mineralization in clinical studies [31]. The progressive increase in grayscale values from the 5th to the 20th week reflects transition from woven bone to more mature lamellar bone. These findings confirm that chitosan significantly enhances osteogenesis in extraction sockets. Cicciu et. al. consistently show 80% complete socket healing by postoperative day 7 versus 50% with gelfoam, with halved antibiotic needs and no increased neurosensory risks [15].

In- vitro assessment of anti-microbial property

Streptococcus species and Lactobacilli species commonly contaminate post-extraction sockets, contributing to infections and delayed healing [32].

Chitosan's cationic nature binds to negatively charged bacterial membranes, leading to permeability changes and cell death, as evidenced by CFU reductions on selective media like blood agar and Rogosa SL agar. The complete inhibition at 1:300-1:400 dilutions suggests potent bactericidal effects even at minimal doses, outperforming controls without chitosan.

In post-extraction sockets, eliminating these microbes via chitosan hydrogel could accelerate socket closure and reduce dry socket risk by preventing biofilm formation. Clinical studies confirm chitosan's dual role in antimicrobial action and promoting osteogenesis, with treated sites showing superior healing at weeks 2–8 compared to untreated ones. These in-vitro results support chitosan's prospective use in clinical settings to enhance wound healing rates while minimizing bacterial load [1].

Limitations: Local chitosan administration cannot completely replace the use of systemic antibiotics, especially in patients with compromised immune system, uncontrolled systemic co-morbidities and other general or localised infections. This material cannot be used in population which has an active peri-apical pathology in or around the surgical site. Chitosan as a material is composed of chitin cells of crustaceans, so it cannot be used in patients with shellfish allergy. This material has limited use in extraction sockets of impacted and unerupted teeth as it known to cause reactionary inflammation, increased chances of infection, delayed wound healing and increased pain scores post extraction [1]. Despite significant radiographic findings, histological confirmation of bone quality was not performed. Cone beam computed tomography could provide volumetric assessment in future studies. The intervention also combined intra-socket powder with repeated topical hydrogel, so the effect of each component cannot be analysed separately. Generalizability is limited to uncomplicated extractions in adults without active infection, tobacco use, or major systemic disease. Additionally, long-term evaluation beyond 20 weeks would clarify remodeling dynamics.

Conclusion

Chitosan is a safe, biocompatible, and effective dressing material for use in post-extraction sockets. Its ability to promote soft tissue healing, assist in hemostasis, and enhance bone regeneration makes it a promising adjunct in routine oral surgical practice. Within the limitations of this study, combined intra-socket and topical chitosan was associated with better soft-tissue healing and higher radiographic indicators of socket mineralization than gelatin sponge. Although it did not significantly reduce postoperative pain, the antimicrobial findings were promising. While the findings are encouraging, further studies with larger sample sizes and longer follow-up periods would be beneficial to validate these results and explore the broader applications of chitosan in oral and maxillofacial surgery. In conclusion, the placement of chitosan in extraction sockets offers a biologically favorable approach to improving postoperative healing outcomes and may play a valuable role in enhancing the quality and predictability of alveolar bone regeneration following tooth extraction.

Declarations

Consent to participate

Informed consent was obtained from all the patients.

Consent to publish

The patients have signed informed consent regarding publishing their data and photographs.

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Competing interests

The authors have no competing interests to declare that are relevant to the content of this article.

Authors contribution

All authors contributed to the study conception and design. All authors have read and approved the final manuscript. Material preparation, operative procedure and writing of first draft of the manuscript was performed by Ishita Doifodey. Operative procedure, final review and editing of the manuscript was done by Arun Vignesh. Randomisation, blind data assessment, final review and editing of the manuscript was done by Komagan Prabhu. Final review and editing of the manuscript was done by Dishari Basu. Material procurement and data collection was done by Ananthnarayanan. Final review of the manuscript was done by V B Krishna Kumar Raja.

Ethics approval

The study was conducted in accordance with the Declaration of Helsinki and ethical approval was granted by the Institutional Ethics Committee (SRMDC/IRB/2023/MDS/No.404).

Consent

All participants received an explanation of the study in a language they understood and provided written informed consent before enrolment.

Data and/or code availability

The data presented in this study are available on request from the corresponding author.

Use of AI

The authors declare the use of artificial intelligence tools for language editing and grammar correction.

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Figures

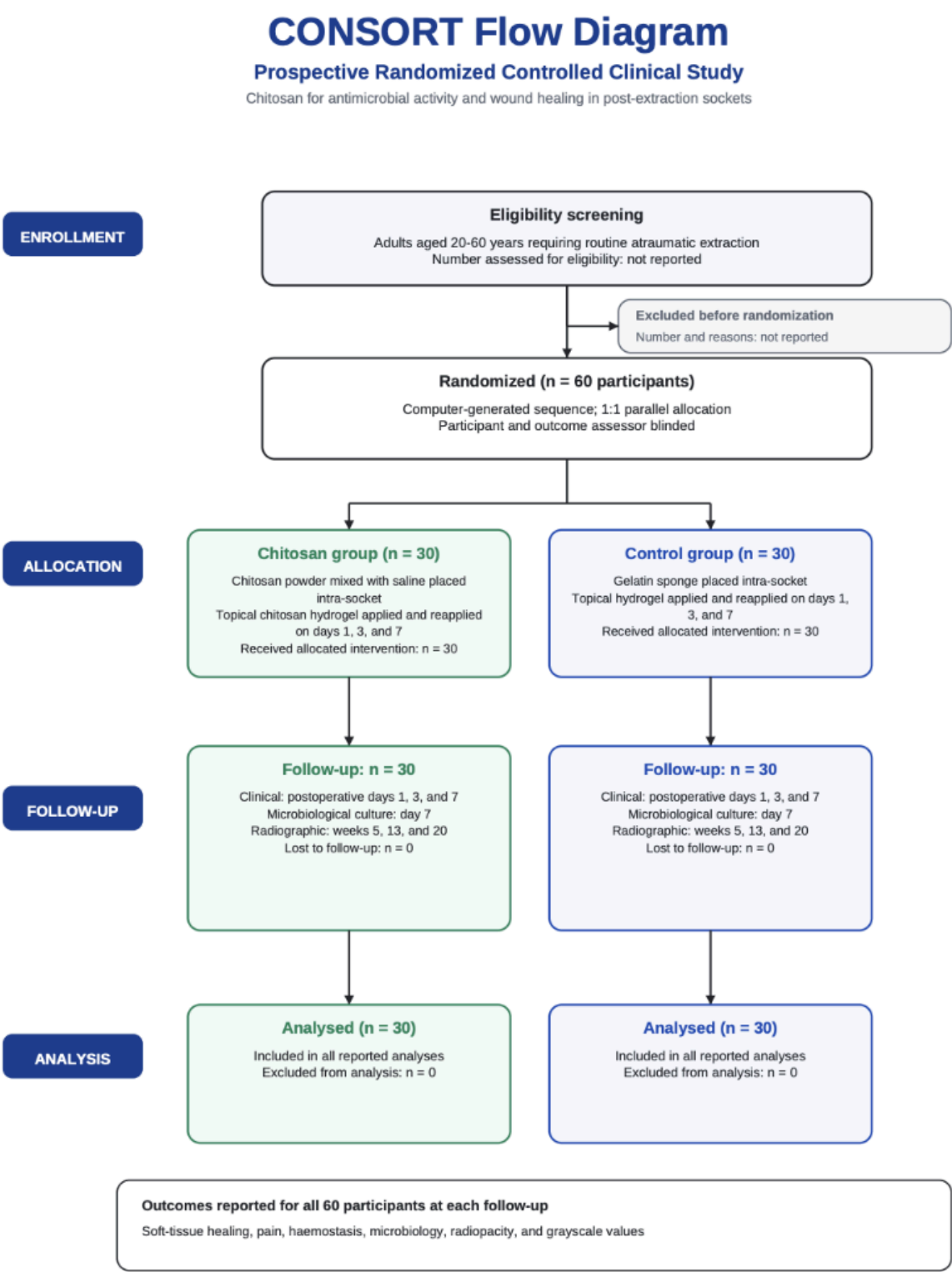


Figure 1

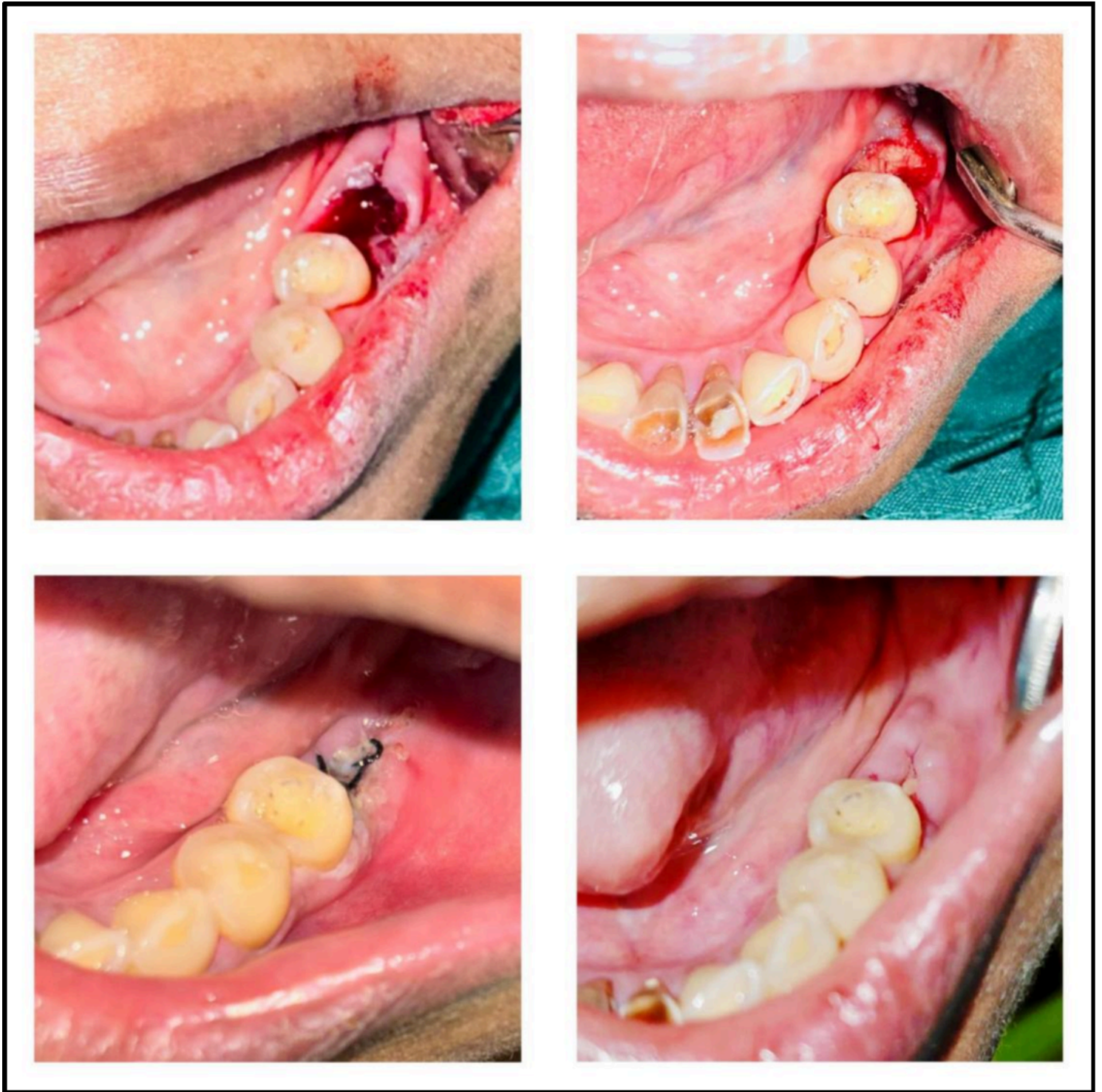


Figure 2

Study Group

a. Immediate post extraction site of 36 (Day 0).

b. Placement of Chitosan fine powder mixed with saline and packed in the socket (Day 0).

c. After placement of 3-0 silk suture, wound healing satisfactory (Day 3).

d. After suture removal, socket completely healed (Day 7).

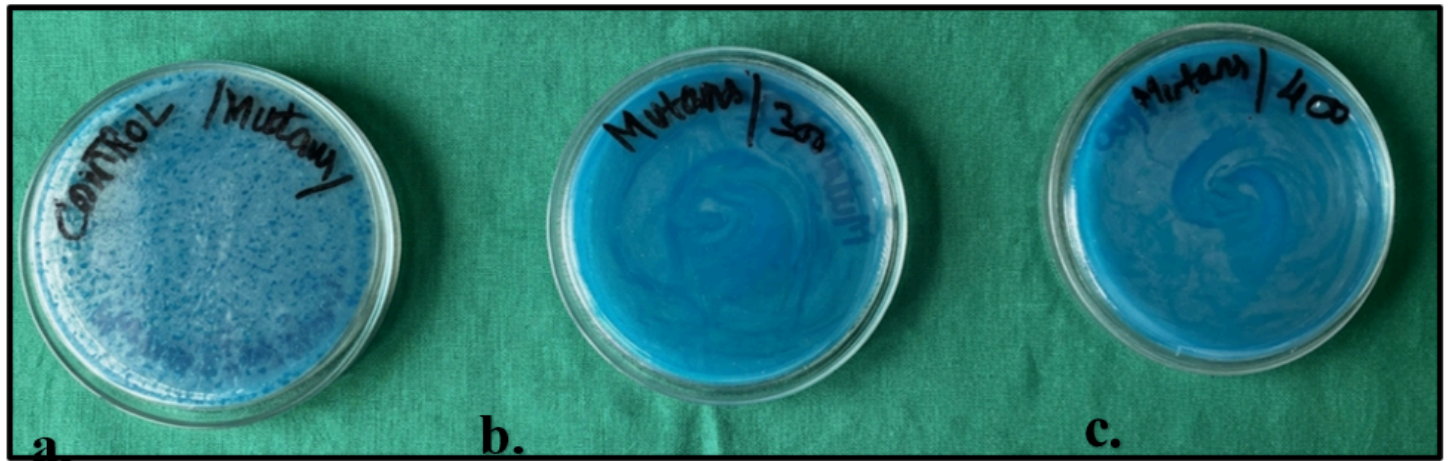


Figure 3

Streptococcus species in Blood agar plate and visualized using an indicator media.

a. Control group- shows presence of 168 CFU/ml of Streptococcus species

b. Study group- shows absence of Streptococcus species at 1: 300 concentration.

c. Study group- shows absence of Streptococcus species At 1: 400 concentration.

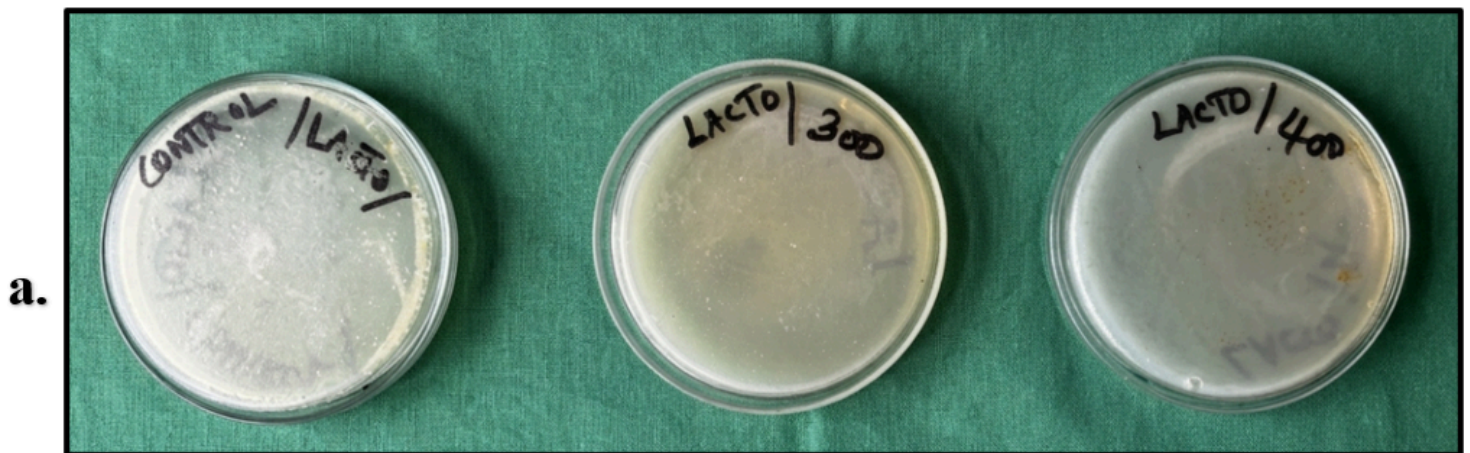


Figure 4

Lactobacilli species In ROGOSA SL Agar Himedia.

a. Control group- shows presence of 15 CFU/ml of Streptococcus species

- b. Study group- shows absence of Streptococcus species at 1: 300 concentration
- c. Study group- shows absence of Streptococcus species At 1: 400 concentration