Bovine-Derived Collagen Membrane as an Advanced Biological Dressing for Minor Intraoral Soft Tissue Defects: A Case Series

Pampana Sravani MDS1, S.Ravi Raja Kumar MDS2, D.Vamsi Krishna Reddy MDS3, Narasimha Rao Guddala MDS4, Ponamandi Nagalakshmi MDS5, Ramalakshmi MDS

[1]Assistant professor, Department of Oral and Maxillofacial Surgery Vishnu Dental College, Bhimavaram, Andhra Pradesh, India

[2] FIBOMS , Professor, Department of Oral and Maxillofacial Surgery, St.Joseph Dental college, Duggirala, Eluru, Andhra Pradesh, India.

[3] Professor, Department of Oral and Maxillofacial Surgery.

[4] Associate professor, Department of Prosthodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.

[5]Assistant professor, Department of Oral and Maxillofacial Surgery Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.

[6]Assistant professor, Department of Public Health Dentistry, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.

Abstract

Background:
Intraoral soft tissue defects frequently occur following dental extractions, trauma, and oral surgical procedures, and often heal by secondary intention. Such wounds are susceptible to postoperative pain, infection, delayed epithelialization, and contracture, which may impair oral function. An ideal biological dressing should protect the wound, reduce morbidity, and promote rapid mucosal regeneration. Bovine-derived collagen membrane (BDCM), known for its biocompatibility, low antigenicity, and ability to support cellular proliferation, has recently gained attention as a biomaterial for intraoral wound coverage. This case series evaluates the clinical effectiveness of BDCM in the management of minor intraoral soft tissue defects.

Case Presentation:
Twenty patients aged 15–60 years with minor intraoral mucosal defects resulting from routine dental procedures (n=9), major oral surgeries (n=9), and trauma (n=2) were treated using BDCM. Following thorough debridement, the membrane was trimmed, adapted to the defect, and secured with resorbable sutures. Postoperative assessments were performed on Day 1, Day 10, at 1 month, and at 3 months, based on nine clinical parameters: hemostasis, pain, swelling, infection, granulation tissue formation, epithelialization, wound contracture, biodegradability, and allergenicity. Nineteen patients demonstrated satisfactory healing outcomes, showing good hemostasis, minimal postoperative pain, absence of infection, early granulation tissue formation, and complete epithelialization. The membrane biodegraded by approximately the 10th postoperative day. One case failed due to inadequate membrane adherence and required secondary intervention. No allergic reactions or adverse events were noted.

Conclusion:

BDCM served as a safe and effective biological dressing for minor intraoral soft tissue defects, promoting rapid epithelialization and stable healing with minimal complications. Its ease of availability and lack of donor-site morbidity make it a viable alternative to autogenous grafts, offering predictable clinical outcomes. Larger randomized controlled clinical trials are recommended to further substantiate these findings.

Keywords :

Biocompatibility; Bovine collagen membrane; Epithelialization; Intraoral defect; Oral wound dressing; Soft tissue healing; Wound management.

Introduction:

Intraoral defects frequently occur as sequelae of various dental and maxillofacial surgical procedures. These lesions are not merely cosmetic concerns; they actively compromise the normal biomechanics of the oral cavity, leading to complications such as chronic food impaction, salivary pooling, and a resultant increase in pathogenic microbial load. This environment elevates the risk of secondary infections, demanding focused and effective wound management strategies[1,2].

The biological response to injury involves a finely tuned sequence of cellular, physiological, and molecular activities aimed at restoring tissue integrity and functional capacity. This process, known as wound healing, is highly susceptible to influence from various intrinsic and extrinsic factors, including the individual's age, nutritional status, systemic health, and medications, as well as the specific size and etiology of the defect. While most wounds heal without intervention, surgical procedures often result in open wounds that must heal by secondary intention. For these defects, a protective dressing is crucial to prevent contamination, minimize contracture, and facilitate optimal healing[3,4].

Historically, wound management relied on passive dressings with limited therapeutic roles. Modern approaches, such as biological dressings like intraoral mucosal grafts or skin grafts, are sometimes utilized for their tissue-inductive potential. However, these techniques face significant drawbacks, including the morbidity and pain associated with a second surgical donor site[2], the limited availability of high-quality mucosal tissue[5], and the functional and aesthetic mismatchsuch as unwanted skin texture or adnexal growthof skin grafts in the oral environment [2,6].

To address the limitations of conventional and biological grafting, research has focused on identifying a soft tissue substitute that is readily available, non-antigenic, and highly biocompatible[1,5,6]. Bovine-derived collagen membrane (BDCM) has emerged as an exceptionally promising material. Collagen, the primary fibrous protein of the extracellular matrix, is valued for its inherent biological and physiological properties, including low immunogenicity, non-toxic nature, and ability to facilitate the migration of fibroblasts and microvascular cells[7,8,9]. Furthermore, BDCM possesses unique features such as strong hemostatic and chemotactic capabilities, resistance to bacterial penetration, and mechanical properties (elasticity, tear strength) suitable for the high-stress environment of the oral cavity[1,8,10]. Chemically, bovine collagen is nearly identical to its human counterpart, minimizing the risk of rejection[8]. While the efficacy of major soft tissue grafts is well-documented, the specific role of collagen membranes in managing minor intraoral defects remains less explored in clinical literature[1]. Therefore, the purpose of this study is to evaluate the clinical efficacy of the bovine-derived collagen membrane in promoting the repair of minor intraoral soft tissue defects,presented in the format of a case series.

Objectives:

1) To evaluate epithelialization and healing at recipient sites after placing the collagen membrane.

2) To assess postoperative complications at the recipient site.

3) To report our clinical experience related to the use of collagen membrane in minor intraoral defects.

Materials and Methodology

1. Study Design and Patient Selection

This investigation was designed as a prospective, single-center case series conducted within the Department of Oral and Maxillofacial Surgery at St Joseph Dental College and Hospital, Duggirala, Eluru.

Patient Selection Process: A cohort of twenty consecutive patients, ranging in age from 15 to 60 years, was enrolled in the study. Patients were selected based on their non-randomized presentation to the clinic with minor intraoral soft tissue defects resulting from dental, surgical, or traumatic incidents. As this is a case series, no patient allocation, group assignment, or randomization was performed. All selected patients received the bovine-derived collagen membrane treatment.

Ethical Clearance: Prior to the commencement of the study and patient enrollment, all protocols were reviewed and approved by the Institutional Ethical Committee. Written informed consent was obtained from every participating patient following a comprehensive explanation of the procedure and follow-up requirements. A standardized proforma was utilized for the systematic collection of necessary patient data.

Inclusion and Exclusion Criteria:

Inclusion Criteria	Exclusion Criteria
Medically fit patients of either gender.	Patients presenting with extensive or very large defects.
Age group between 15 and 60 years.	Cases involving preoperative infection at the recipient site.
Patients presenting with minor intraoral soft tissue defects.	Patients with a documented history of allergy or hypersensitivity to collagen-based products.

2. Materials

Collagen Membrane: A xenogenous collagen membrane (EUCARE Pharmaceuticals Private Limited; Chennai, India) was used as the biological wound dressing. This material consists of highly purified, reconstituted bovine Type I and Type III collagen derived from the Serosa layer. The collagen is processed and subsequently cross-linked using tanning agents like glutaraldehyde or chromium sulfate. This cross-linking process is performed to enhance the membrane's tensile strength, reduce its rate of biodegradation, and minimize its antigenicity. Each membrane was supplied in a dimension with a uniform thickness of 5*5mm. The material was sterilized via gamma irradiation and provided in aluminum pouch packaging containing a sterile mixture of isopropyl alcohol and water.

Additional Materials:

- Standard oral and maxillofacial surgical armamentarium.
- Polyglactin 910 suture material (Vicryl 3-0) for fixation.

3. Methodology and Surgical Protocol

Preoperative Evaluation: All patients underwent a comprehensive preoperative work-up which included a detailed case history, thorough clinical and radiographic examinations, all requisite hematological investigations, and, where indicated, a pre-anaesthetic evaluation.

Wound Management and Dressing Application: The defects varied in etiology: nine patients presented with defects following routine dental procedures or minor surgery, nine patients after major surgical procedures, and two patients due to trauma.

1. Debridement: All intraoral mucosal defects were meticulously debrided under either local or general anesthesia to ensure a clean, viable wound bed.
2. Preparation of the Membrane: The collagen membrane was carefully removed from its sterile aluminum pouch and thoroughly rinsed in sterile normal saline solution to remove the preserving medium (isopropyl alcohol and water).
3. Sizing and Placement: The membrane was trimmed using scissors to slightly exceed the dimensions of the defect. It was then adapted over the wound.
4. Fixation: The membrane was secured to the surrounding mucosal margins using Polyglactin (3-0 Vicryl) interrupted sutures.
5. Drainage Enhancement: To promote drainage and prevent fluid accumulation beneath the graft, several small criss-cross incisions were made across the surface of the collagen membrane, and a few quilting sutures were placed for improved adaptation to the wound base. The membrane was generally observed to show a degree of physiological sloughing approximately ten days post-procedure.

4. Postoperative Management and Assessment

Antibiotic Regimen: Postoperative antibiotic prophylaxis was tailored based on the complexity of the preceding procedure:

- Minor Procedures: Patients with defects following routine dental procedures received oral antibiotics (Capsule Amoxicillin-Clavulanic Acid twice daily and Tablet Metronidazole three times daily) for five days.
- Major Procedures: Patients with defects following major surgical procedures received parenteral broad-spectrum antibiotics (Injection Cefotaxime every 12 hours and Injection Metronidazole every 8 hours) administered intravenously from the time of admission until the fifth postoperative day.

Follow-up and Data Collection: All patients were followed up for a minimum period of 3 months. Comprehensive photographic and necessary hematological records were maintained throughout the study period.

Clinical Assessment Parameters: Postoperative assessment was carried out using the following nine clinical parameters to determine the efficacy of the collagen membrane:

1. Hemostasis achieved at the defective site.
2. Postoperative pain levels.
3. Presence and extent of swelling.
4. Presence of wound infection at the grafted site.
5. Quality and rate of granulation tissue formation.
6. Rate and extent of epithelialization of the membrane.
7. Degree of wound contraction.
8. Biodegradability (resorption rate) of the membrane.
9. Allergic or adverse reactions to the collagen membrane.

1. Patient Cohort and Defect Etiology

The study was conducted on a total of twenty patients (aged 15–60 years) presenting with minor intraoral mucosal defects at the Department of Oral and Maxillofacial Surgery, St. Joseph Dental College and Hospital. All patients were treated by covering the defect with a bovine-derived collagen membrane (BDCM) under local or general anesthesia.

The patients were categorized based on the underlying etiology of the mucosal defect:

- Cases 1 to 9: Defects resulting from routine dental procedures or minor surgical interventions.
- Cases 10 to 18: Defects occurring secondary to major surgical procedures (e.g., maxillectomy, excision of tumors, cleft palate repair, BSSO advancement).
- Cases 19 and 20: Soft tissue defects resulting from acute trauma.

The specific diagnoses and corresponding treatment procedures for all twenty patients are detailed in Table 1.

Case Number	Diagnosis	Surgical Procedure & Intervention
I. Minor Surgical Procedures / Dental Procedures (Cases 1–9)		
Case 1	Alveolar osteitis (48 region)	Wound debridement followed by BDCM coverage.
Case 2	Post mucosal defect (mandibular anterior apicectomy)	Defect coverage using BDCM.
Case 3	Oro-antral communication (16 region)	Direct closure followed by BDCM placement.
Case 4	Alveolar osteitis (36 region)	Wound debridement followed by BDCM placement.
Case 5	Alveolar osteitis (16 region)	Wound debridement followed by BDCM placement.
Case 6	Post-surgical mucosal defect (surgical removal of impacted 47, 48)	Mucosal defect closure using BDCM.
Case 7	Oro-antral communication (26 region)	Direct closure followed by BDCM placement.
Case 8	Dry socket (16 region)	Wound debridement and BDCM coverage.
Case 9	Mucosal defect (maxillary anterior apicectomy)	Mucosal defect closure using BDCM.
II. Major Surgical Procedures (Cases 10–18)		
Case 10	Capillary hemangioma (right maxillary posterior region)	Post-maxillectomy defect closed using buccal fat pad posteriorly and BDCM anteriorly.
Case 11	Chronic osteomyelitis of the maxilla (left side)	Surgical excision of the lesion followed by BDCM coverage.
Case 12	Pleomorphic adenoma (hard palate)	Post-surgical defect covered with BDCM.
Case 13	Oral submucous fibrosis (bilateral buccal mucosa)	Bilateral surgical excision of fibrous bands followed by BDCM coverage.
Case 14	Post-surgical mucosal defect (BSSO advancement, right side)	Mucosal defect at 46 and 47 region closed with BDCM.
Case 15	Post-surgical defect (anterior mandibular region after ameloblastoma removal)	Wound margins refreshed, followed by BDCM closure.
Case 16	Recurrent odontogenic myxoma (right maxillary anterior region)	Surgical excision of the lesion followed by BDCM coverage.
Case 17	Post-surgical mucosal defect (surgical closure of cleft palate, left maxilla)	BDCM used to cover the defect.
Case 18	Pyogenic granuloma (incisive papilla region)	Surgical excision followed by BDCM coverage.
III. Traumatic Defects (Cases 19–20)		
Case 19	Mucosal defect (lower labial region, 32 to 42, due to trauma)	Wound debridement followed by BDCM placement.
Case 20	Mucosal defect (lower labial region, 33 to 42, due to trauma)	Wound debridement followed by BDCM placement.

2. Clinical Assessment Protocol

Postoperative clinical parameters were assessed at four distinct time points: the first postoperative day (Day 1), the tenth postoperative day (Day 10), the first month (Month 1), and the third month (Month 3). Pain assessment was recorded based on the patient's subjective report, while the remaining eight criteria were evaluated objectively through clinical examination of mucosal changes.

The nine criteria evaluated were: Hemostasis, Pain, Swelling, Wound infection, Granulation tissue formation, Epithelialization, Wound contracture, Biodegradability of the membrane, and Allergenicity.

3. Postoperative Clinical Outcomes

The following clinical observations were made across the cohort of twenty patients:

General Observations:

- All patients reported comfort with the intraoral placement of the collagen graft.
- A transient complaint of odor sensation was reported by three patients (Case numbers 3, 5, and 7).
- No adverse reactions or signs of allergenicity to the grafted material were reported in any case.

Efficacy Parameters (95% Success Rate):

- Hemostasis: Hemostasis was rated as good in 19 cases (95%) and fair in only one case (Case 18).
- Pain Relief: Pain relief was considered good in 19 cases (95%).
- Swelling and Infection: No noticeable swelling or wound infection was observed at the grafted site in any of the twenty cases (100%).
- Granulation and Epithelialization: Good granulation tissue formation and subsequent epithelialization were observed in 19 cases (95%).
- Wound Contracture: No wound contracture was observed at the treatment site in any case (100%).

Biodegradability:

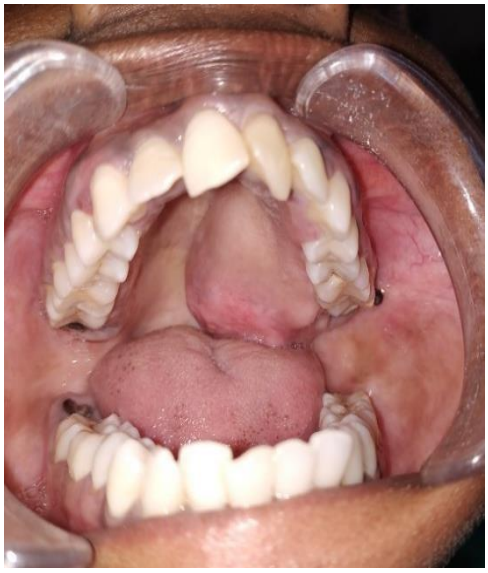
- In the cases where the membrane successfully adhered and integrated, the adhered collagen membrane was observed to undergo complete biodegradation on the average of the 10th postoperative day.

Treatment Failure:

- One case (Case 14), representing of the cohort, was recorded as a failure in terms of pain relief and granulation. In this patient, the BDCM failed to maintain adherence to

the underlying wound bed. The membrane was subsequently removed, and the defect required resuturing.

In the present study, the use of the bovine-derived collagen membrane as a biological dressing material over intraoral mucosal defects resulted in uneventful wound healing and epithelialization in of the cases. With a near-complete absence of swelling, infection, and allergic reactions, the collagen membrane demonstrated its potential as a biologically safe and effective dressing material.



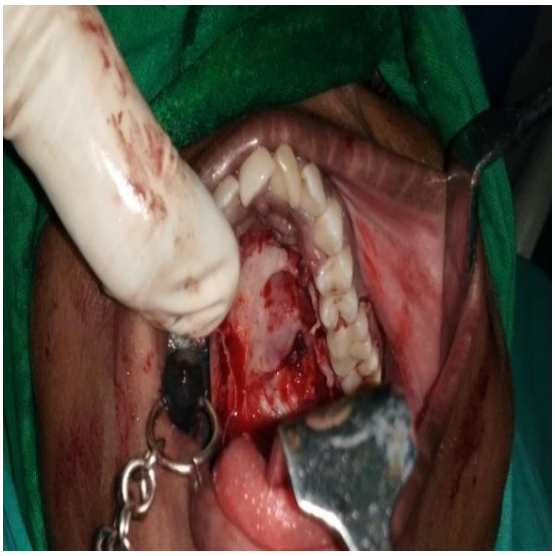
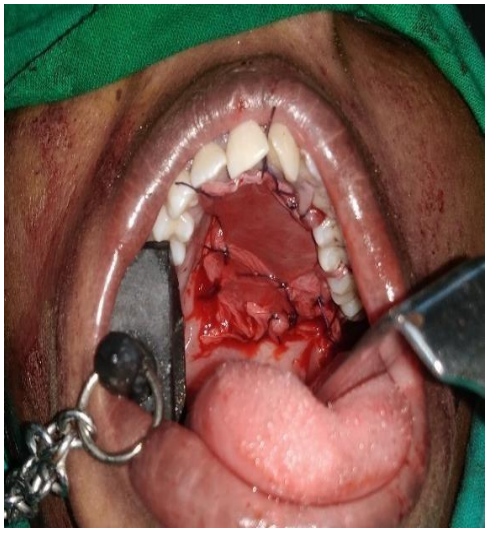


Fig 1: Pleomorphic adenoma of hard palate (Case 12) Fig 2: Intra op defect after removal of adenoma



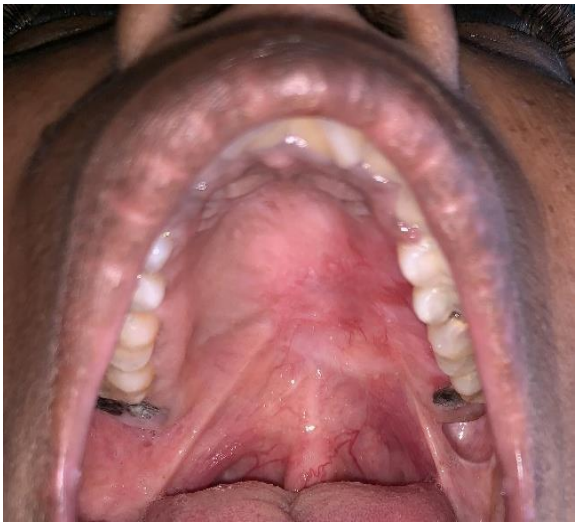


Fig 3: Collagen placed and secured with 3-0 vicryl Fig 4: Wound healing after 3 months

Discussion

The management of intraoral soft tissue defects remains a significant challenge in oral and maxillofacial surgery. Procedures ranging from simple tooth extractions to complex tumour resections frequently result in open wounds that must heal by secondary intention [3,4]. This process, while natural, is inherently slow, carries a higher risk of infection and excessive wound contraction, and necessitates the use of a suitable dressing material to modulate the wound microenvironment [5]. This prospective case series aimed to evaluate the clinical efficacy and safety of a bovine-derived collagen membrane (BDCM) as a biological dressing for minor intraoral defects in twenty consecutive patients.

Biological Principles of Wound Healing and BDCM

Wound healing is a complex, orchestrated biological cascade that involves four overlapping phases: hemostasis, inflammation, proliferation, and remodeling. The process is initiated by hemostasis, where vasoconstriction and platelet activation lead to the formation of a fibrin-fibronectin clot. This provisional matrix acts as a crucial scaffold, providing chemotactic signals for inflammatory cells and facilitating the migration of epithelial cells and fibroblasts into the healing zone[10].

Following the inflammatory phase, the proliferation phase begins, characterized by angiogenesis, granulation tissue formation, and re-epithelialization. Granulation tissue, composed of fibroblasts, macrophages, and new capillary networks, forms the foundation for repair[4]. When a defect is left open, as in the cases presented here, healing by secondary intention occurs. This relies on epithelial cell migration across the surface of the granulation tissue, a process that can be slow and prone to complication. The final stage, the maturation/contraction phase, involves the differentiation of fibroblasts into myofibroblasts, which actively close the distance between wound edges, followed by the remodeling of the collagen matrix[11].

Performance of BDCM Against Clinical Parameters

The results of the present study demonstrate that the BDCM effectively facilitated uneventful healing in of cases, proving its ability to fulfill the criteria of an ideal soft tissue dressing.

1. Hemostasis and Pain Reduction

The immediate role of any wound dressing is achieving hemostasis and reducing pain. Collagen's inherent structure is highly thrombogenic, promoting platelet adhesion and subsequent aggregation to form a stable hemostatic plug[3]. This function was validated in our study, where good hemostasis was observed in 19 of 20 cases . Furthermore, the membrane provided rapid and significant pain relief, rated as good in of patients. This is consistent with previous findings in the study Raghavendra Reddy et al., 2012[12].that the collagen sheet acts as a physical barrier, effectively covering sensitive nerve endings and diminishing the degree of immediate postoperative pain.

2. Granulation and Epithelialization

A critical observation in this case series was the high rate of successful wound healing, with good granulation tissue formation and epithelialization noted in of cases. Collagen

provides a biocompatible matrix that is chemotactic for fibroblasts and promotes cell migration. By maintaining a moist environment and providing a scaffold for cellular ingrowth, the BDCM fostered the uniform development of clinically healthy granulation tissue. This biological scaffolding function allowed peripheral epithelium to migrate effectively, leading to rapid re-epithelialization within four to five weeks[14]. The sustained contact of the membrane with the wound bed during the initial healing phase was therefore crucial for success.

3. Biodegradability and Adherence

In the successful cases, the adhered collagen membrane underwent complete biodegradability, on average, by the 10th postoperative day. This timing is highly favorable, as the membrane remains in place long enough to guide initial cellular processes and resist masticatory forces before the underlying granulation tissue is robust enough to take over. Adherence of the membrane was observed in of cases, primarily attributed to the interaction between fibrin and the collagen surface, followed by fibrovascular ingrowth [2]. The single case of failure (Case 14), where the membrane failed to adhere and required removal and resuturing, underscores the necessity of optimal primary fixation and a clean recipient site.

4. Safety and Adverse Reactions

Importantly, no noticeable swelling, infection, or allergic reactions were observed in any patient. This validates the biological safety of the purified, reconstituted, and cross-linked xenogenous collagen. The manufacturing process, which involves chemical modification to minimize antigenicity [14], ensured the material's excellent biocompatibility[15].

Comparative Advantage Over Traditional Grafts

Traditional methods for covering intraoral defects, such as mucosal autografts, split-thickness skin grafts, and pedicled flaps (e.g., nasolabial or tongue flaps), all carry significant drawbacks. The most pertinent disadvantage is the necessity for a second surgical site and the associated donor site morbidity, pain, and limited material availability [5].

Furthermore, while skin grafts are readily available, they fail to achieve the texture, resiliency, or color of the native oral mucosa and may exhibit adnexal structure growth. Local flaps, such as the buccal fat pad, are unreliable under masticatory stress, and tongue flaps cause substantial patient discomfort [6]. The BDCM circumvents all these limitations, offering an off-the-shelf, ready-to-use, non-immunogenic material that provides a safe and effective temporary cover.

Versatility

The efficacy of collagen has been extensively documented beyond soft tissue defects, including applications in guided bone regeneration [16], socket preservation [17], and oro-antral fistula closure [18]. Our successful closure of oro-antral communications (Cases 3 and 7) and coverage of defects resulting from major tumor excisions and trauma further highlights the versatility and clinical utility of the BDCM.

The findings from this case series, supported by established biological principles, strongly suggest that the bovine-derived collagen membrane is a safe, versatile, and highly effective biological dressing for promoting the repair of minor intraoral soft tissue defects, achieving excellent hemostasis, pain control, and epithelialization rates.

Conclusion

This prospective case series successfully demonstrated the clinical efficacy and safety of the bovine-derived collagen membrane (BDCM) as a biological dressing for the repair of minor intraoral soft tissue defects.

The application of BDCM resulted in uneventful wound healing in of patients, achieving rapid hemostasis, significant postoperative pain reduction, and timely epithelialization. Crucially, the material exhibited excellent biocompatibility, with no reported instances of infection, swelling, or allergic reaction. The BDCM's ability to undergo complete biodegradation, on average by the 10th postoperative day, ensures its role as an effective temporary scaffold.

The bovine-derived collagen membrane is therefore a safe, versatile, and highly effective material that provides a valuable, off-the-shelf alternative to traditional autogenous grafts, circumventing the morbidity associated with a second surgical site. While this case series provides strong clinical evidence, further large-scale randomized controlled trials are recommended to statistically compare the BDCM with other established modalities.

Ethical Consideration

The present study adhered to the ethical standards outlined in the Declaration of Helsinki (1975), as revised in 2013, and was approved by the Institutional Ethical Committee of St. Joseph Dental College and Hospital, Eluru. All patients were thoroughly informed about the nature of the study, the surgical procedure involved, alternative treatment options, anticipated benefits, and possible postoperative complications. Written informed consent was obtained from each participant prior to enrollment.

Patient confidentiality was maintained throughout the study by avoiding disclosure of personal identifiers in clinical records, photographic documentation, and publication. Participation was entirely voluntary, and patients were given the right to withdraw from the study at any time without any compromise in their ongoing treatment. No financial burden or compensation was involved, and the study material (collagen membrane) was used without additional cost to the patients.

Informed Consent

Written informed consent was obtained from all patients prior to participation and publication of clinical data and images.

Conflict of Interest

The authors declare that they have no financial or personal relationships that could inappropriately influence or bias the work reported in this study. No funding was received for the conduct of this research or preparation of this manuscript. The authors alone are responsible for the content and writing of the paper.

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