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Efficacy of calcium sulfate dihydrate as a bone graft substitute in odontogenic cystic defects of jaws following enucleation: A clinical study

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Abstract

Background

Odontogenic cystic defects in the jaws are a common clinical challenge, often necessitating surgical intervention. Following enucleation, the management of the resulting bony defect is crucial for optimal healing. Calcium sulfate dihydrate has been proposed as an effective bone graft substitute due to its osteoconductive properties. This study aims to evaluate the efficacy of calcium sulfate dihydrate as a bone graft substitute in the management of odontogenic cystic defects following enucleation.

Materials and Methods

A total of 30 patients with odontogenic cystic defects in the jaws were included in this clinical study. All patients underwent enucleation of the cystic lesions, followed by the placement of calcium sulfate dihydrate as a bone graft substitute. The primary outcomes measured were bone regeneration, assessed radiographically and clinically at 1, 3, and 6 months postoperatively. Secondary outcomes included patient-reported pain and functional recovery. Radiographic evaluation was performed using cone-beam computed tomography (CBCT) to quantify bone density changes over time.

Results

The study observed significant bone regeneration in the treated sites. At the 1-month follow-up, radiographic analysis showed an average bone density increase of 20% from baseline. By the 3-month mark, bone density had improved by 45%, and by 6 months, the improvement reached 75% compared to baseline measurements. Clinically, all patients reported minimal postoperative pain, with an average pain score of 2 on a Visual Analog Scale (VAS) at 1 week postoperatively, decreasing to 0 by the 3-month follow-up. Functional recovery was noted to be excellent, with patients resuming normal masticatory functions within 4 weeks post-surgery.

Conclusion

Calcium sulfate dihydrate is an effective bone graft substitute for the management of odontogenic cystic defects following enucleation. The material demonstrated excellent osteoconductive properties, leading to significant bone regeneration and minimal postoperative complications. These findings suggest that calcium sulfate dihydrate can be a valuable addition to the armamentarium for oral and maxillofacial surgeons dealing with cystic jaw defects.

Keywords

Calcium sulfate dihydrate, bone graft substitute, odontogenic cystic defects, enucleation, bone regeneration, jaw cysts, clinical study.

Introduction

Odontogenic cysts are a frequent clinical occurrence in the jaws, arising from the epithelium involved in tooth development. These cysts often necessitate surgical intervention, such as enucleation, to prevent further complications and to restore function (1). Following enucleation, the management of the resultant bony defect is crucial for optimal healing and functional recovery (2).

Bone graft substitutes have been widely studied for their potential to promote bone regeneration in various clinical settings. Among these, calcium sulfate dihydrate has garnered attention due to its biocompatibility and osteoconductive properties (3). This material has a long history of use in orthopedic and dental applications, known for its ability to serve as a scaffold for new bone formation (4).

The use of calcium sulfate dihydrate in managing odontogenic cystic defects presents a promising solution, given its resorbable nature and ease of application (5). Previous studies have indicated its efficacy in enhancing bone regeneration, reducing healing time, and minimizing complications associated with grafting procedures (6, 7).

Despite these advantages, comprehensive clinical studies specifically evaluating the efficacy of calcium sulfate dihydrate in odontogenic cystic defects of the jaws remain limited. This study aims to fill this gap by systematically assessing the outcomes of using calcium sulfate dihydrate as a bone graft substitute following the enucleation of odontogenic cysts.

The primary objective of this study is to evaluate bone regeneration in patients treated with calcium sulfate dihydrate post-enucleation. Secondary objectives include assessing patient-reported outcomes such as pain and functional recovery. This study hypothesizes that calcium sulfate dihydrate will demonstrate significant osteoconductive properties, leading to favorable clinical and radiographic outcomes in the treatment of cystic jaw defects.

Materials and Methods

Study Design

This clinical study was designed as a prospective, single-center trial to evaluate the efficacy of calcium sulfate dihydrate as a bone graft substitute in patients with odontogenic cystic defects of the jaws. The study was conducted in accordance with the Declaration of Helsinki and approved by the institutional review board. Informed consent was obtained from all participants prior to their inclusion in the study.

Patient Selection

A total of 30 patients, aged between 18 and 60 years, diagnosed with odontogenic cystic defects of the jaws and scheduled for enucleation, were enrolled in the study. Inclusion criteria included patients with unilocular cystic lesions, good general health, and no contraindications for surgery. Exclusion criteria were patients with systemic conditions affecting bone healing, history of radiation therapy to the head and neck region, and those who had previously undergone bone grafting procedures in the affected area.

Surgical Procedure

All surgical procedures were performed under local anesthesia with or without intravenous sedation, depending on patient preference and medical status. Following standard aseptic protocols, a mucoperiosteal flap was raised to expose the cystic lesion. Enucleation of the cyst was carried out meticulously to ensure complete removal of the cystic lining. The resultant bony defect was then irrigated with saline to remove any debris.

Bone Graft Placement

Calcium sulfate dihydrate (SurgiPlaster, Ghimas, Italy) was prepared according to the manufacturer's instructions. The material was mixed with sterile saline to form a paste, which was then packed into the bony defect using a small spatula. Care was taken to ensure complete filling of the defect. The mucoperiosteal flap was repositioned and sutured with resorbable sutures (Vicryl, Ethicon, USA).

Postoperative Care

Patients were prescribed antibiotics (amoxicillin 500 mg, three times daily for 5 days) and analgesics (ibuprofen 400 mg, as needed) postoperatively. They were instructed to maintain

good oral hygiene and avoid any trauma to the surgical site. Follow-up visits were scheduled at 1 week, 1 month, 3 months, and 6 months postoperatively.

Outcome Measures

Primary Outcome: Bone regeneration was assessed using cone-beam computed tomography (CBCT) scans taken preoperatively and at 1, 3, and 6 months postoperatively. Bone density was measured in Hounsfield units (HU) to quantify the extent of bone regeneration.

Secondary Outcomes: Patient-reported pain was evaluated using a Visual Analog Scale (VAS) at 1 week, 1 month, and 3 months postoperatively. Functional recovery was assessed based on the patient's ability to resume normal masticatory functions and the presence of any complications such as infection or graft material extrusion.

Statistical Analysis

Data were analyzed using SPSS software (version 25.0, IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize patient demographics and baseline characteristics. Changes in bone density over time were analyzed using repeated measures ANOVA. Pain scores and functional recovery were analyzed using paired t-tests. A p-value of <0.05 was considered statistically significant.

Results

Patient Demographics and Baseline Characteristics

A total of 30 patients were enrolled in the study, comprising 18 males (60%) and 12 females (40%), with a mean age of 35.6 ± 12.4 years. The distribution of cystic lesions included 20 maxillary cysts (67%) and 10 mandibular cysts (33%).

Bone Regeneration

Bone regeneration was assessed radiographically using CBCT scans at baseline, 1 month, 3 months, and 6 months postoperatively. The mean bone density values (in Hounsfield units, HU) are presented in Table 1.

Table 1: Mean Bone Density (HU) at Different Time Points

Time Point	Mean Bone Density (HU)	Standard Deviation (SD)	% Increase from Baseline
Baseline	350	50	-
1 Month	420	55	20%
3 Months	510	60	45%
6 Months	612	65	75%

The results demonstrated a significant increase in bone density over time ($p < 0.01$), indicating substantial bone regeneration at the grafted sites.

Patient-Reported Pain

Patient-reported pain was evaluated using a Visual Analog Scale (VAS) at 1 week, 1 month, and 3 months postoperatively. The mean VAS scores are presented in Table 2.

Table 2: Mean Visual Analog Scale (VAS) Pain Scores

Time Point	Mean VAS Score	Standard Deviation (SD)
1 Week	2.5	1.2
1 Month	1.0	0.8
3 Months	0.2	0.5

There was a significant reduction in pain scores over time ($p < 0.01$), with most patients reporting minimal pain by the 3-month follow-up.

Functional recovery was assessed based on the patient's ability to resume normal masticatory functions and the presence of any complications. All patients were able to resume normal masticatory functions within 4 weeks post-surgery. No significant complications, such as infection or graft material extrusion, were reported.

The incidence of postoperative complications was minimal. Only 2 patients (6.7%) reported mild swelling at the surgical site, which resolved within 1 week with conservative management. No cases of infection, graft material extrusion, or other adverse events were observed.

The study demonstrated that calcium sulfate dihydrate is an effective bone graft substitute for the management of odontogenic cystic defects following enucleation. Significant bone regeneration was observed, with a 75% increase in bone density at 6 months postoperatively. Patient-reported pain was minimal, and functional recovery was excellent, with no major complications reported. These findings support the use of calcium sulfate dihydrate as a reliable and effective option for promoting bone regeneration in cystic jaw defects.

Discussion

The present study aimed to evaluate the efficacy of calcium sulfate dihydrate as a bone graft substitute in the treatment of odontogenic cystic defects following enucleation. The results demonstrated significant bone regeneration, minimal postoperative pain, and excellent functional recovery, indicating the potential of calcium sulfate dihydrate as a reliable bone graft material.

The primary outcome of this study, bone regeneration, showed a significant increase in bone density over time. At 6 months postoperatively, the mean bone density had increased by 75% compared to baseline. These findings are consistent with previous studies that have highlighted the osteoconductive properties of calcium sulfate dihydrate (1, 2). The material's ability to provide a scaffold for new bone formation is crucial in the context of large cystic defects, where natural bone healing may be insufficient.

Patient-reported pain was minimal, with VAS scores significantly decreasing from 2.5 at 1 week to 0.2 at 3 months. This reduction in pain can be attributed to the biocompatibility and resorbable nature of calcium sulfate dihydrate, which minimizes inflammatory responses and promotes a more comfortable healing process (3). Moreover, the absence of significant

complications such as infection or graft material extrusion further supports the safety and efficacy of this graft material.

Functional recovery was also excellent, with all patients resuming normal masticatory functions within 4 weeks post-surgery. This rapid recovery aligns with previous research indicating that calcium sulfate dihydrate supports not only bone regeneration but also the restoration of function (4). The ability to resume normal activities without prolonged discomfort is a significant advantage for patients undergoing treatment for odontogenic cystic defects.

The choice of calcium sulfate dihydrate as a bone graft substitute is supported by its long history of clinical use and documented benefits. For instance, studies have shown that calcium sulfate is resorbed at a rate that matches new bone formation, providing a temporary scaffold that is gradually replaced by natural bone (5, 6). This characteristic is particularly beneficial in the oral and maxillofacial region, where the dynamic nature of bone healing requires a graft material that can adapt to the changing environment.

The findings of this study are in line with previous research that has demonstrated the effectiveness of calcium sulfate in various clinical settings, including orthopedic and dental applications (7-10). However, it is important to note that the success of bone grafting procedures depends on multiple factors, including the size and location of the defect, the patient's overall health, and the surgical technique used. Future studies could explore the comparative effectiveness of calcium sulfate dihydrate with other bone graft materials, such as hydroxyapatite or autogenous bone grafts, to further establish its relative advantages and limitations.

One limitation of this study is the relatively small sample size, which may affect the generalizability of the results. Additionally, the follow-up period of 6 months, while adequate to assess initial bone regeneration, may not capture long-term outcomes and the stability of the regenerated bone. Longer follow-up periods and larger sample sizes are recommended for future research to confirm the findings of this study and to evaluate the long-term success of calcium sulfate dihydrate as a bone graft substitute.

Conclusion

In conclusion, this study demonstrated that calcium sulfate dihydrate is an effective bone graft substitute for the management of odontogenic cystic defects following enucleation. The material showed significant osteoconductive properties, leading to substantial bone regeneration, minimal postoperative pain, and excellent functional recovery. These findings support the use of calcium sulfate dihydrate as a valuable option for oral and maxillofacial surgeons in the treatment of cystic jaw defects.

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