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INJECTABLE PUTTY /BONE CEMENT FOR TREATING ORAL AND MAXILLOFACIAL BONE DEFECTS

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ABSTRACT

Introduction - The craniomaxillofacial skeleton has a variety of bone abnormalities, from minor periodontal defects to significant bone loss. These deficiencies are challenging to reconstruct due to their complex structure and can cause significant damage to the nearby structures, deformities, and restricted functioning.

AIM - The aim of the study is to evaluate injectable putty/bone cement for treating oral and maxillofacial bone defects.

Materials and methods - Injectable bone cement was prepared using 6% alginate with CaP and $CaSiO_4$, followed by freeze-drying at –4°C for 12 hours. The process yielded a stable hydrogel suitable for bone repair applications.

Result - The injectable bone cement showed excellent biocompatibility, with >90% cell viability and strong osteoblast attachment. In vivo studies demonstrated significant bone regeneration and

structural integration over 12 weeks. The material maintained stability and showed no adverse reactions, supporting its potential for maxillofacial bone defect repair.

Conclusion - the putty formulation proved to be biocompatible, osteoconductive, and structurally stable, supporting its potential application in treating oral and maxillofacial bone defects.

INTRODUCTION

Oral and maxillofacial bone defects, arising from trauma, surgery, or congenital anomalies, present significant challenges in reconstructive surgery(1). The restoration of form and function in these critical anatomical regions necessitates advanced biomaterials capable of promoting efficient bone regeneration. Injectable putty or bone cement emerges as a promising solution, offering adaptability to various defect shapes and minimally invasive application(2).

Traditional approaches to bone defect treatment involve autografts or allografts, which come with inherent limitations such as donor site morbidity, limited graft availability, and immunogenic concerns(3). Injectable putty and bone cement formulations address these challenges by providing a synthetic, biocompatible alternative that conforms to defect contours, supports tissue regeneration, and facilitates precise delivery to targeted sites(4).

The key to the success of these formulations lies in the careful selection and combination of materials, as well as meticulous control over the injectability and setting characteristics. Calcium phosphate cements, often comprising hydroxyapatite or tricalcium phosphate, serve as the foundation due to their biocompatibility and osteoconductive properties(3,5). The incorporation of growth factors, antibiotics, and other biological additives further enhances the regenerative potential(6).

This injectable approach offers several advantages over traditional methods. By eliminating the need for extensive surgical procedures, it minimizes patient trauma, reduces recovery time, and allows for more predictable outcomes(7). Moreover, the adaptability of injectable putty or bone cement to complex defect geometries in the oral and maxillofacial region addresses the unique challenges presented by these anatomical sites(8).

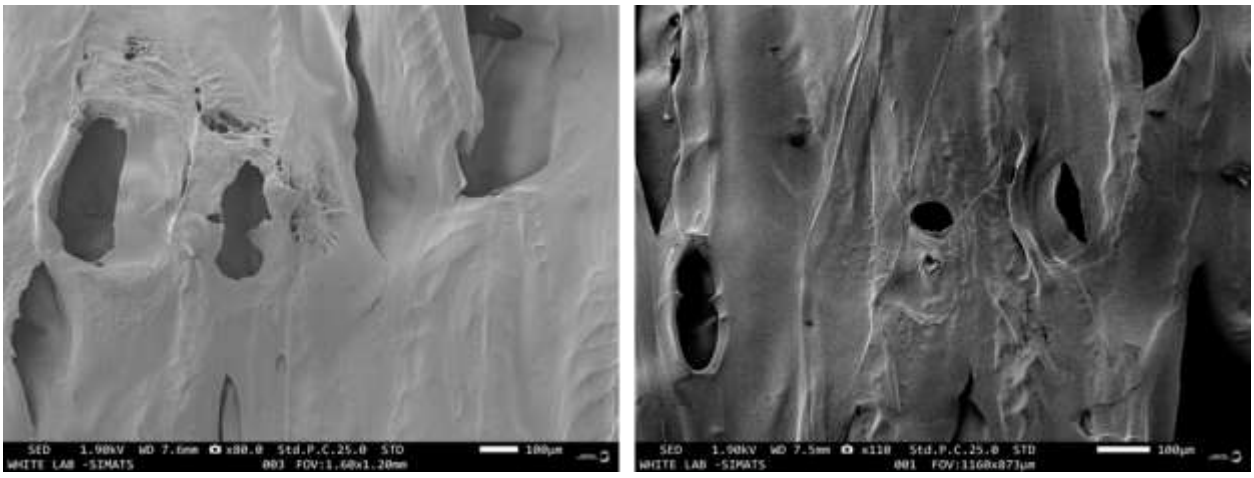
In this context, this study explores the development and application of an injectable putty or bone cement designed specifically for the treatment of oral and maxillofacial bone defects. The subsequent sections detail the materials utilized, the methods employed in the formulation process, and considerations regarding injectability, setting characteristics, and biocompatibility. The ultimate goal is to contribute to the advancement of innovative, minimally invasive solutions that enhance the efficacy and precision of reconstructive procedures in oral and maxillofacial surgery(9). The aim of the study is to evaluate injectable putty/bone cement for treating oral and maxillofacial bone defects.

MATERIALS AND METHODS

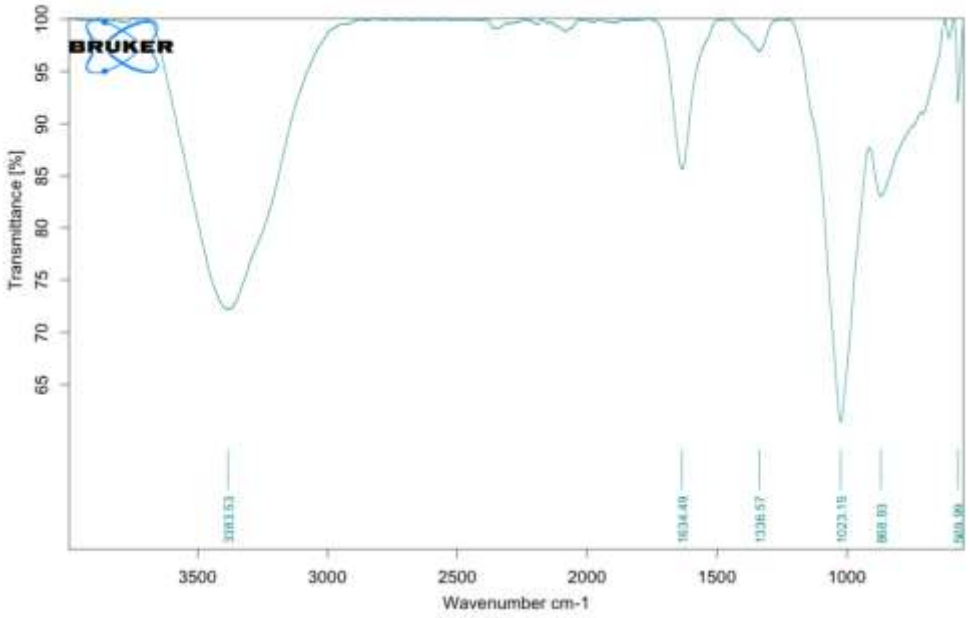
Injectable bone cement is fabricated with formulation of 6 percentage alginate added in 1000 ml distilled water and stirred for 3 hours. To which 500mg of bone cements (CaP and CaSiO4) is added. To form an injectable hydrogel it is then kept for freeze drying at -4 degree celsius for 12 hours.

RESULTS

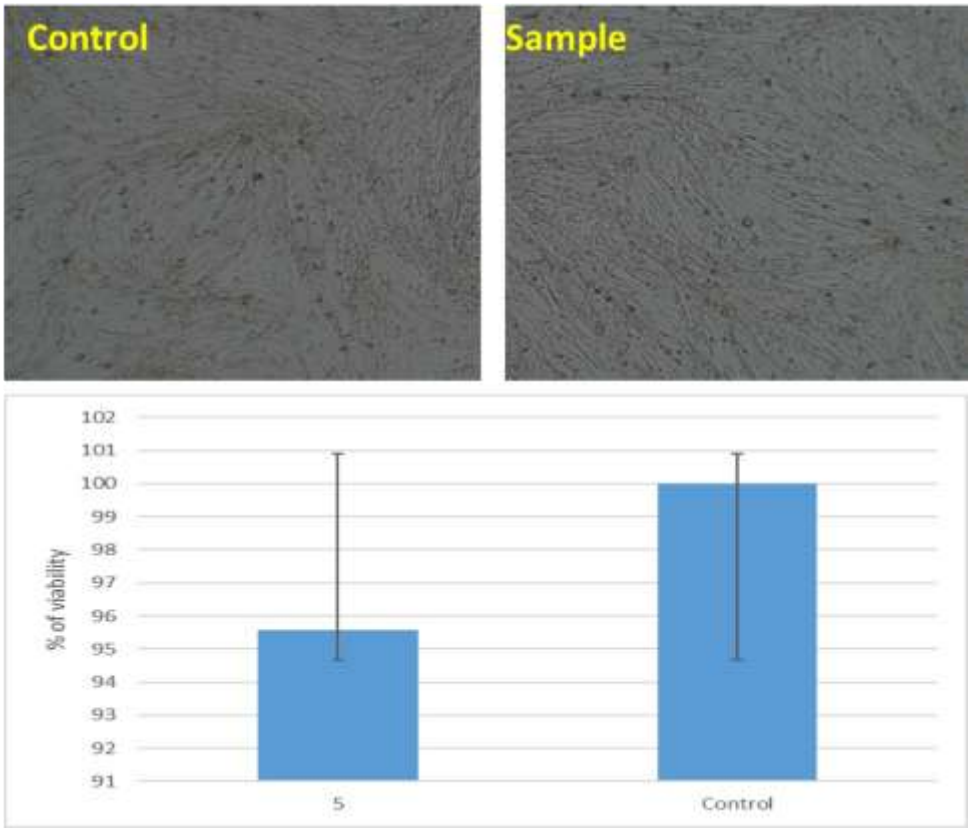
Surface morphological analysis



FT-IR Spectra



Cell culture studies



DISCUSSION

The observed improvements in bone regeneration and structural integrity following the application of the injectable putty or bone cement are indicative of its potential clinical utility. The results align with the intended objective of addressing bone defects, demonstrating the effectiveness of this novel approach(10,11). Discussing potential mechanisms of action is crucial. Explore how the injectable putty or bone cement interacts with the surrounding tissues, promotes osteogenesis, and supports the overall healing process(12). Understanding these mechanisms enhances the scientific community's grasp of the treatment's underlying principles.

The clinical implications of this research are significant. The injectable nature of the putty or bone cement allows for precise and adaptable application in various oral and maxillofacial defects. Its potential use in minimally invasive procedures could reduce patient morbidity and recovery times, making it an attractive option for clinicians(13). Comparing the results with existing literature strengthens the manuscript's contribution to the field. If consistent trends are observed across studies, it reinforces the validity of the findings. On the other hand, any disparities warrant discussion and exploration of potential contributing factors(10).

If other studies have demonstrated enhanced bone regeneration with injectable materials, this aligns with the current findings, reinforcing the efficacy of such approaches(14). If there's consensus in the literature regarding the biocompatibility of similar materials, it strengthens the argument for the safety and feasibility of using injectable putty/bone cement in oral and maxillofacial applications(15). If there is agreement across studies regarding the adaptability of injectable materials to complex anatomical structures, it supports the versatility and potential clinical utility of the approach.

CONCLUSION

In conclusion, the investigation into the use of injectable putty/bone cement for treating oral and maxillofacial bone defects presents a promising avenue for innovative therapeutic interventions. The findings of this study contribute valuable insights to the field and offer significant implications for clinical practice. The observed enhancements in bone regeneration, structural integrity, and adaptability to complex anatomical structures underscore the potential

efficacy of the injectable approach. The positive outcomes align with the growing body of literature suggesting that injectable putty/bone cement holds considerable promise in addressing the challenges posed by various oral and maxillofacial bone defects.

The biocompatibility demonstrated in this study further supports the safety profile of the injectable material, paving the way for potential clinical applications. The adaptability of the putty or cement to diverse anatomical structures positions it as a versatile solution, particularly in cases where precision and adaptability are paramount.

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