

Proceeding



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Comparison of the diametral tensile strength of bone cement based on carbonate apatite between micron and nano particles calcium carbonate as a precursor

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ABSTRACT

INTRODUCTION: Bone cement is inorganic material which can be used for bone substitute materials. One of the bone cement which has been attracted much attention in orthopedic and dental fields is apatite cement. As a result of apatite cement could transform to carbonate apatite (CO₃Ap) after implanted in the body, high bone replacement ability could be developed. The current study about diametral tensile strength (DTS) value of bone cement using calcium carbonate (CaCO₃) as one of the component of CO₃Ap cement in limited to submicron particles. There have been no data using CaCO₃ reduced into nano particles. Meanwhile, the studies about reduction of CaCO₃ particles into nano particles have been found by the precipitation and ultrafine grinding. **Objective:** The aim of this study is to investigate the DTS value of bone cement based on CO₃Ap between micron and nano particles using CaCO₃ as a precursor. **Materials and methods:** The powder phase of micron particles of CaCO₃ or nano particles of CaCO₃ which was milled by beads mill combined with dicalcium phosphate anhydrous (CaHPO₄) was mixed with 1 mol/L of disodium hydrogen phosphate (Na₂HPO₄) solution in 0.5 of liquid to powder ratio. The paste was packed into a split Teflon mold, covered with glass slide and kept at 37°C and 100% relative humidity for 24 hours. **Results:** The result showed that the diametral tensile strength of the set CO₃Ap cement using micron particles of CaCO₃ was 3,7787 MPa and nano particles of CaCO₃ was 2,4013 MPa. The data was analyzed statistically with t independent test ($\alpha=0,05$) which showed that the DTS between micron and nano particles of CaCO₃ was statistically significant. **Conclusion:** In conclusion, the bone cement based on CO₃Ap using micron particles of CaCO₃ has higher DTS value than bone cement based on CO₃Ap with nano particles of CaCO₃.

Keywords: *Diametral tensile strength, bone cement, carbonate apatite, calcium carbonate*

INTRODUCTION

Bone is one of important parts in our body that support our bodies and protect vital organs such as heart, lungs, etc. Bone has limitation for self repair. When large defect bone occurs, so the repair processed need an alternative materials as a bone graft [1]. Autograft is one of the bone grafting materials which is still considered as the “golden standard” compared to other grafting materials since it shows high remodelling process performance. This material is harvested from healthy parts of the bones of the same patient. However, the availability of the healthy bone in our body is limited and this may involve massive blood loss, sepsis, and also pain [1, 2]. Therefore, the use of synthetic graft can be used as an alternative material for bone substitute [3].

Bone cement is a synthetic bone graft material (alloplastic) which can be used for bone substitute materials [4]. One of the bone cement which has been attracted much attention in orthopedic and dental fields is apatite cement (AC) [5]. The AC could transform to carbonate apatite (CO_3Ap) when implanted in the body and high bone replacement ability could be developed. Another advantages possessed by AC lies in its ability to show good osteoconductivity and excellent tissue response [6].

The candidates of starting material for fabrication of CO_3Ap cement are calcium carbonate (CaCO_3) and dicalcium phosphate anhydrous (CaHPO_4) [6]. Cahyanto *et al.* reported that CO_3Ap cement consisted of one of the polymorph of CaCO_3 which is vaterite that has the smallest particle size with the highest diametral tensile strength (DTS) [7]. However, the current study about DTS value of bone cement using CaCO_3 as one of the component of CO_3Ap cement was limited. Furthermore, there was no data using CaCO_3 reduced into nanoparticles as a precursor for CO_3Ap cement. Meanwhile, the study about reduction of CaCO_3 particles into nanoparticles has been found by the precipitation and ultrafine grinding [8]. The aim of this study was to investigate the DTS value of bone cement based on CO_3Ap between micron and nanoparticles using CaCO_3 as a precursor.

METHODS

This research was conducted by CO_3Ap based bone cement using micron and nanoparticles of CaCO_3 . The nanoparticles of CaCO_3 were derived on the basis of previous report [8]. In brief, 1.15 mL of Tween 80 as the surfactant was mixed into 568.1 mL aquadest and 5.75 g of CaCO_3 using magnetic stirrer. The grinding was conducted by beads mill for 3 hours at the slurry concentration of 5%, bead size of 300 μm , and the rotor speed 3000 rpm. The obtained particles were collected by dried at 40°C for 24 hours. Finally, each micron particles of CaCO_3 and nanoparticles of CaCO_3 were mixed with CaHPO_4 homogeneously on weight powder ratio 40:60 to obtain CO_3Ap powder.

Powder phase of CaCO_3 combined CaHPO_4 were mixed with liquid phase of 1 mol/L Na_3HPO_3 using a spatula at a L/P ratio 0.5 until it became a paste. The paste was packed into Teflon mold (6 mm in diameter x 3 mm in height). Both ends of the mold was covered