Physical characterization and osteogenic activity of the quaternized chitosan-loaded PMMA bone cement

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1. Introduction

The treatment of osteomyelitis and infected arthroplasty is challenging. Local debridement, removal of implants, irrigations, obliteration of dead space, osseous repair, and systemic use of antibiotics for long periods of time are the standard procedures for treating orthopedic infections [1]. Because of the compromised vascularity, the existence of necrotic tissue, and bacterial biofilm formation on the surface of the implant, it is difficult to obtain an effective local antibiotic concentration by systemic administration [1]. Furthermore, intravenous antibiotic therapy using multiple antibiotics with high serum concentrations may carry the risk of systemic toxicity. Therefore, there has been increased interest in local antibiotic delivery systems, which yield higher local antibiotic concentrations [2–4].

Local antibiotic delivery vehicles that have been reported for treating orthopedic infections include polymethylmethacrylate (PMMA), poly(lactic acid) (PLA), poly(lactic acid-co-glycolic acid) (PLGA), poly(ε-lysine) (P,LA), calcium phosphate paste, hydroxyapatite, tricalcium phosphate and plaster of Paris [4,5]. However, the most widely studied and applied material is PMMA bone cement, which was first introduced by Buchholz et al. [6]. Antibiotic-loaded PMMA has been proven to be successful for the treatment and prevention of osseous infections, and represents the current gold standard for local antibiotic delivery systems in orthopedic surgery [7]. PMMA bone cement loaded with gentamicin is normally used for total hip and total knee arthroplasties during primary and revision surgeries, and has proven to be an effective practice for preventing and treating infections after total joint replacement [8–12]. In addition, gentamicin-loaded PMMA beads have been one of the most widely used local antibiotics in clinical practice, especially for osteomyelitis therapy [13–15]. However, the local overuse of antibiotics also leads to the evolution of antibiotic-resistant bacteria, which accounts for the failure of anti-infective treatments [11,16]. Thus, it is necessary to find more effective antimicrobial agents to load into PMMA against antibiotic-resistant organisms.