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臺灣大學應用力學研究所

演 講 公 告

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主 講 人：陳祥和教授兼主任

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講　　題：利用生物力學優化醫療器材的設計與開發

摘　　要：　如附件

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☆☆ 歡 迎 聽 講 ，敬 請 張 貼 ☆☆

利用生物力學優化醫療器材的設計與開發
Optimizing the Research & Development of Medical Devices with Biomechanics

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Abstract：

For students in applied mechanics, I would like to share my experiences in research and development of medical devices with Biomechanics. The main works are our previous studies on biodegradable Mg-based metallic glass for developing a new suture anchor. Mg-based alloys have great potential for development into fixation implants because of their highly biocompatible and biodegradable metallic properties. My recent study sought to determine the biocompatibility of $Mg_{60}Zn_{35}Ca_5$ bulk metallic glass composite (BMGC) with fabricated implants in a rabbit tendon–bone interference fixation model. The cellular cytotoxicity of $Mg_{60}Zn_{35}Ca_5$ BMGC toward rabbit osteoblasts in comparison with conventional titanium alloy (Ti6Al4V) and polylactic acid (PLA) was investigated. The results show that $Mg_{60}Zn_{35}Ca_5$ BMGC may be classed as slightly toxic on the basis of the standard ISO 10993-5. The osteogenic effect of the $Mg_{60}Zn_{35}Ca_5$ BMGC extraction medium on rabbit osteoblasts was further characterized by quantifying extracellular calcium and mineral deposition, as well as cellular alkaline phosphatase activity. The results of these tests were found to be promising. The chemotactic effect of the $Mg_{60}Zn_{35}Ca_5$ BMGC extraction medium on rabbit osteoblasts was demonstrated through a transwell migration assay. For the in vivo section of this study, a rabbit tendon–bone interference fixation model was established to determine the biocompatibility and osteogenic potential of $Mg_{60}Zn_{35}Ca_5$ BMGC in a created bony tunnel for a period of up to 24 weeks. The results show that $Mg_{60}Zn_{35}Ca_5$ BMGC induced considerable new bone formation at the implant site in comparison with conventional titanium alloy after 24 weeks of implantation. In conclusion, this study revealed that $Mg_{60}Zn_{35}Ca_5$ BMGC demonstrated adequate biocompatibility and exhibited significant osteogenic potential both in vitro and in vivo. These advantages may be clinically beneficial to the development of $Mg_{60}Zn_{35}Ca_5$ BMGC implants for future applications. The suture anchor is a medical device commonly used in surgery of rotator cuff tear repairment to fix tendons onto the greater tuberosity of the humerus. Factors related to both patients and devices could cause failures in clinical results, such as structural designs and poor bone density. In my study, a new suture anchor design with four distinctive parameters was created and the structural performance was optimized in a full factorial experimental design using finite element analysis. Two types of bone blocks, normal and osteoporotic bone, which were implanted with screws, were simulated to investigate the parametrical effects on different bone qualities. Prescribed motion in a constant removal velocity was used to evaluate pullout strength. The von Mises criterion was used in force control simulation for topology optimization. Also, mechanical tests instructed by ASTM-F543-20 were conducted for validation. This study demonstrates a comprehensive process to develop a suture anchor that would have enough mechanical integrity for clinical use and investigates the contributions of each distinctive design parameters within this application.