以光彈分析法研究貼附基質物理性質與細胞貼附之關係

Photoelastic Analysis of the Relationship between Physical Properties of Substrate and Cell Attachment

中文摘要

自生醫材料被應用於治療中，如何使細胞快速有效整合漸爲學者們所關注的焦點。1965 年 Carter 發現細胞貼附與化學刺激（chemotaxis）有關後，至今影響細胞貼附、遷移之因子，如光線 (phototaxis)、靜電力 (galvanotaxis)、重力 (geotaxis)、外部應力 (mechanical stress)、表面孔徑 (pore size)、粗糙度(roughness)等均陸續被發現，唯獨生醫材料內部殘存應力分布狀態對細胞貼附所造成的影響，目前仍未見有系統之探討。因此本研究即在於分析貼附基質（substrate）殘存應力分佈與細胞貼附間之關係。本研究以臨床上被接受、可使用於植體手術、具有良好生物相容性之聚乳酸（PLA）作爲貼附基質，控制聚乳酸射出成型溫度（170、175、180、185、190℃）以控制殘存應力分布狀態，並利用光彈分析法檢測之。於聚乳酸植體試樣上培養 NIH-3T3 及 MG-63 細胞，觀察高、低殘存應力區間之細胞分佈情形。本研究發現 95% PLLA + 5% PDLLA 的聚乳酸試樣，細胞經培養 48 小時後，兩種細胞皆有往低殘存應力區分佈的趨勢（$p < 0.05$），且細胞分佈與殘存應力具線性關係（NIH-3T3：$y = -2.65x + 24.52$, $R = 0.8021$, $p=0.00002 < 0.05$；MG-63：$y = -2.76x + 22.37$, $R = 0.6283$, $p = 0.00299 < 0.05$），顯示細胞行爲會受生物材料內部殘存應力所影響，本研究可做爲未來進一步定量探討殘存應力與細胞行爲相關性研究的基礎，並對未來生醫材料的製作提供建議。

英文摘要

Since biomaterial applications are introduced to oral rehabilitation, researchers have increasing interest as to how to have cells integrate onto implants efficiently. In 1965, Carter first discovered the correlation between cell attachment and chemotaxis, factors affecting the attachment and migration of cells such as phototaxis, galvanotaxis, geotaxis, mechanical stress, pore size, and roughness etc. have continuously been discussed over years. However, the effects of internal stress distribution within the substrate itself (ex. implant) on cell attachment have not yet been systematic investigated. Thus, the objective of this research is to analyze the relationship between the distribution of internal stress within the substrate and cell attachment.There are a variety of biomaterials introduced into medical field, such as metallic materials (ex. titanium), polymeric materials (ex. poly(L-lactide)), etc.. This study uses poly(L-lactide)(PLLA) as substrate. PLLA is clinically accepted, able to be used in implant surgery, and possesses good biocompatibility. To alternate the internal stress of PLLA discs, discs were set at various temperature and time of polymerization. The distributions of internal stress were examined by photoelastic method. NIH/3T3 fibroblast cells were cultured on PLLA discs, and cell distributions at high-stress region and low-stress region were compared after 48 hours.Out results demonstrated that the cell number at low-stress region is larger than high-stress region ($p<0.05$). Furthermore, there is no significant difference ($p>0.05$) in cell number between the two regions with equal stress (NIH-3T3：$y = -2.65x + 24.52$, $R = 0.8021$, $p =0.00002 < 0.05$；MG-63：$y = -2.76x + 22.37$, $R = 0.6283$, $p = 0.00299 < 0.05$).The results of this study indicate that the distributions of internal stress of the substrate (i.e. the implant itself) do affect the behavior of early cell attachment. These results give more insight into the interaction behavior between cell and substrate. It will serve as an important reference for future clinical study.