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Nicotine Increases Osteoblast Activity of Induced Bone Marrow Stromal Cells in a Dose-Dependent Manner: An in vitro Cell Culture Experiment

Previous studies by our group showed that nicotine delivered via a transdermal nicotine patch significantly enhanced posterior spinal fusion rates in rabbits. Nicotine transdermal patches provide a steady serum level; there may be a dose-dependent effect of nicotine on posterior spinal fusion. In an in vitro cell culture model of rabbit bone marrow-derived osteoblast-like cells, cells were exposed to different concentrations of nicotine (0, 20, 40, 80 ng/mL and 10, 100, 250 µg/mL). Wells were stained with an alkaline phosphatase (ALP) staining kit to determine ALP enzyme activity. Cells were stained with Von Kossa for mineralization. A two-way analysis of variance (ANOVA) using dose and time as variables showed significant differences among groups; post hoc analysis showed that the 100-µg/mL dose of nicotine significantly enhanced ALP activity over controls. A one-way ANOVA using dose as the variable showed that the 100- and 250-µg/mL doses had significantly greater mineralization than controls. Dose-response analysis revealed a statistically significant effect of nicotine dose on ALP activity and Von Kossa activity. The effects of nicotine on spinal fusion may be dose-dependent and due to stimulation of osteoblastic activity. Nicotine may not be responsible for the inhibited bone healing observed in smokers.

Keywords

nicotine - bone healing - spinal fusion - osteoblasts - smoking

以劑量依賴性的方式，尼古丁能提高誘導骨髓基質幹細胞的成骨細胞活性: 體外細胞培養實驗

本團隊以往的研究發現，以透皮尼古丁貼劑釋放尼古丁能顯著增加兔後路脊柱融合率。尼古丁透皮貼劑提供了一個穩定的水平，有可能是尼古丁的劑量依賴性對後路脊柱融合術的效應。在體外細胞培養模型的兔子骨髓來源的成骨細胞樣細胞，細胞暴露於不同濃度的尼古丁（0，20，40，80 ng / mL 和 10，100，250 µg / mL）。之後以鹼性磷酸酶（ALP）染色試劑盒染色，以確定鹼性磷酸酶活性。細胞以馮庫薩染色為礦化。雙因素方差分析（ANOVA），以劑量和時間為可變因素表現出組間的顯著差異; 事後分析發現，100- µg/mL 劑量的尼古丁能顯著增強 ALP 活性。使用劑量為可變因素的單因子變異數分析發現，與對照組別相比，100 - 和 250- µg/mL 的劑量是顯著地有更大的礦化。劑量 - 反應分析顯示尼古丁劑量對 ALP 活性和馮庫薩染色活性在統計學上有明顯的影響。尼古丁對脊柱融合的影響可能是劑量依賴性的及由於刺激成骨細胞活性所造成。尼古丁可能並不是如觀察吸煙者中負責抑制骨癒合。