

How to manage bone union in spine fusion surgery

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In this era of aging societies, the number of elderly individuals who undergo spinal arthrodesis for various degenerative diseases is increasing. Poor bone quality and osteogenic ability in older patients, due to osteoporosis, often interfere with achieving bone fusion after spinal arthrodesis. Advancement in spinal instrumentations has significantly increased fusion rate. However, the validated biomechanical properties of modern instrumentation cannot attain 100% fusion rate because the induction of heterotopic bone formation requires a complex balance of biologic factors and operative technique to achieve successful fusion. In the first part, I will discuss about what we should know and what we can do to improve fusion rate under current condition. First, we have to pay attention to the cell sources which contribute spinal fusion which includes osteoblast (OB) inside grafted autograft, OB or mesenchymal cells (MC) migrated from adjacent bones and MC migrated through the blood stream. And we also have to think about the sum of factors affecting spinal fusion which consists of surgical factors, implant factors, patient factors and biologic enhancement. Next, I will talk about the future perspective of biologic enhancement of spinal fusion by introducing our basic research. Several biological enhancement strategies of bone formation have been conducted in animal models of spinal arthrodesis and human clinical trials. Pharmacological agents for osteoporosis have also been shown to be effective in enhancing bone fusion. Cytokines, which activate bone formation, such as bone morphogenetic proteins, other cytokines are used are be researched to enhance bone fusion for spinal arthrodesis. Recently, stem cells have attracted considerable attention as a cell source of osteoblasts, promising effects in enhancing bone fusion. Drug delivery systems will also need to be further developed to assure the safe delivery of bone-enhancing agents to the site of spinal arthrodesis. In addition, I will introduce in vivo imaging system of ectopic bone formation process which we established recently by using two-photon excitation microscopy. These advance in basic research are expected to facilitate spinal fusion, but we have to keep in mind that surgical preparation of fusion bed plays a crucial role for acquiring spinal fusion even in the era that biological enhancement of spinal fusion is well advanced.