Repair of articular cartilage defect with layered chondrocyte sheets and cultured synovial cells

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1. Introduction

Articular cartilage is avascular tissue nourished by synovial fluid. Articular cartilage shows limited capacity for regeneration after degeneration or injury [1], and leads to osteoarthritis (“OA”). As societies age, much attention is being focused on OA prevention and countermeasures. Treatments for osteochondral defects have included to date: micro fracturing [2–4], mosaicplasty [5–7] and endoprosthetic joint replacement. Beginning with the report by Brittberg et al. [11] of autologous chondrocyte implantation (ACI), as a result of development in tissue engineering research a variety of cultured cell graft techniques [11–25] have become the subject of further enquiry. Microfracture surgery and drilling are techniques that encourage natural repair by filling osteochondral defects with marrow-derived repair cells. Normally, an osteochondral defect will induce the production of marrow-derived repair cells [8]. Osteochondral defects are generally thought to be ultimately replaced by subchondral bone after infiltration by blood vessels during endochondral ossification of chondrocytes from multipotent, marrow-derived MSC [9,10]. Nagai et al. fabricated tissue-engineered cartilage without a scaffold and reported that chondrocyte plates were effective at repairing tissue in animal experiments [21,22]. The usefulness of temperature-responsive culture dishes was reported by Okano et al. [26,27]. Previously, myocardial, corneal and other types of cell sheets have been reported [28–30].

We are continuing to conduct animal experiments with the aim of developing clinical applications for articular cartilage treatment using cell sheets with adhesive properties that were obtained from temperature-responsive culture dishes. Kaneshiro et al. achieved good treatment outcomes by transplantation chondrocyte sheets into partial defect models [31]. Furthermore, Mitani et al. investigated chondrocyte sheets molecular-biologically and immunohistochemically, and examined the chondrocyte repair process [32].

Cartilage repair using synovial cell grafts has been carried out. Hunziker et al. have reported synovial cells played an important role in the repair of the cartilage defects [43], and Koga et al. have created osteochondral defects in rabbit knee joints and reported good results from grafts of synovium-derived mesenchymal stem cells used in conjunction with periosteum [44]. However, Ando et al. investigated repair of articular cartilage using chondrocytes and