Expanded human meniscus-derived cells in 3-D polymer–hyaluronan scaffolds for meniscus repair

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1. Introduction

The meniscus of the knee joint was initially considered to be functionless, but it is now known to have important functions in shock absorption, joint lubrication, stability of the knee joint, and protection from cartilage damage. The wedge-shaped knee meniscus tissue contains mainly water (72%) and collagen (22%) [6]. Particularly in the avascular inner region of the meniscus, the phenotype of the tissue is fibro-cartilage-like, whereas the vascular peripheral zone shows a fibrous phenotype [7]. The matrix of the meniscus is composed mainly of collagen type I (over 90%), but also a number of minor collagens (e.g., types II–VI), and extracellular proteins like aggrecan (ACAN) and glycosaminoglycans (GAG) are also present in small quantities. The collagen type I is arranged in bundles for strong tensile stress absorption and maintains the structural integrity of the meniscus during load bearing [5,7–10].

A decrease in the amount of meniscus tissue can lead to cartilage degeneration, an increase in pain and a loss of joint function. Meniscus lesions are frequently occurring injuries and pose a complex problem in orthopedic practice. After meniscus injury, a partial or total resection is often necessary. Only injuries in the outer vascularized part of the meniscus may heal spontaneously or upon suturing, while the inner avascular region shows a low capacity for self-regeneration. Due to the notoriously limited self-healing capacity of the meniscus fibro-cartilage-tissue, meniscectomy often leads to the degeneration of the articular cartilage of the knee joint and the later development of osteoarthritis in the knee [11–13].

Current repair techniques are effective in the peripheral vascularized meniscus, but their success in the avascularized region is not reliable. Tissue engineering, combining cell culture techniques and scaffold materials for tissue repair, offers new treatment options for meniscus repair of the avascular region and even enables whole meniscus replacement by an in vitro engineered construct [14].