Are Collagen Meniscus Implants a Reality?

To the Editor:

Menisci play a fundamental role in the knee joint, maintaining the knee’s homeostasis and biomechanics. The main functions of the menisci include force transmission, shock absorption, lubrication, adjustment to tibial surfaces, proprioception, body weight distribution, pressure resistance, modulation of femoral condyle shape, and joint stabilization during flexion and extension.

The number of meniscal lesions has increased markedly in recent years because of greater participation in sports. Also, cartilage-like menisci can be found in osteoarthritis related to mechanical damage and aging.

Currently, the most common surgical intervention performed by orthopedic surgeons is for meniscal lesions. More than 1 million surgical interventions involving the meniscus are performed annually in the United States and approximately 400,000 in Europe. The arthroscopic meniscal resection is one of the most common surgical procedures performed worldwide.

The subsequent loss of some amount of meniscal tissue alters this protective function by modifying the pattern of load distribution, leading to osteoarthritis and irreversible joint damage. The extent to which meniscectomy results in clinically significant outcomes is uncertain, despite studies using meniscal scaffolds in animals.

The best treatment for meniscal injury is the meniscal repair preserving the meniscus by suturing the lesion, calling for the need to "save the meniscus.”

For irreparable lesions, partial meniscectomy is the current standard of care due to short surgical time, low morbidity, low costs, fast recovery, and usually good early results. In these cases, and in an effort to keep the knee functional and pain free, interest in meniscal preservation techniques has increased during the past few decades. Functional repair of the meniscus remains a significant challenge in orthopedic surgery.

Meniscal tissue-engineered implants with proper pores geometry and architecture were developed as a promising option for regeneration of partial native tissue loss. In these cases, replacing the removed meniscal tissue with a prosthetic meniscus could offer a solution and prevent degeneration.

Only 1 meniscus scaffold has been shown to replace lost or damaged meniscus tissue in human clinical studies—the collagen meniscal implant (CMI). Otherwise, materials such as bacterial cellulose gel or human autologous meniscus cells extended in high-density cultures have been used in an attempt to promote cell migration and serve as a meniscal matrix implant.

The CMI is designed to replace the irreparable damaged or missing portion of the meniscus in a chronic meniscal injury, and has not been found to benefit patients with an acute injury. The ideal case has an intact meniscal rim and anterior and posterior horns for good attachment and stability of the scaffold fixing it with proper suture materials. However, a case has been reported of semitendinosus tendon autograft for reconstruction of the meniscal wall supporting a collagen implant. In addition, the site surgically prepared for the CMI must extend at least into the red-white zone of the meniscus to provide sufficient vascular supply, although mesenchymal stem cells/collagen-scaffold sandwiched implants in vitro have been made for the repair of white zone meniscal cartilage tears.

According to the available literature, meniscal substitution with the CMI has provided significant pain relief and functional improvement after a minimum of 10 years’ follow-up. The implant generally diminishes in size. However, the procedure has proved to be safe and to have a low rate of implant failure long-term. A specific clinically relevant inflammatory or immune response has been absent.

A novel biodegradable, synthetic, acellular scaffold composed of aliphatic polyurethane (Actifit; Orteq Ltd, London, United Kingdom) is used for the treatment of medial or lateral irreparable partial meniscal tears. The urethane segments are more stable than the polycaprolactone segments and will eventually be safely phagocytized by macrophages or giant cells or become integrated into the surrounding tissue.

No difference in clinical and radiological outcomes between medial and lateral CMIs appeared to be observed at 12 months postoperatively. Nevertheless, medial CMIs seem to provide better clinical and radiological outcomes at long-term follow-up than partial medial meniscectomy. The CMI appears to support regeneration with tissue ingrowth if given an appropriate environment, does not appear to be rejected, and is resorbed over time.

Regeneration of meniscal cartilage is possible through the development of meniscal scaffolds. Symptomatic patients with an irreparable chronic meniscal injury or chronic pain after partial meniscectomy appear to benefit the most. Various materials have been tested, but none has had the properties required to restore normal function of a native meniscus. Therefore, the degradation time for these scaffolds may be too short.
scale studies with longer follow-up are needed. Further improvements in the implant, model, and surgical technique are essential.

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