Postoperative Imaging of the Knee

Meniscus, Cartilage, and Ligaments

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KEYWORDS

• MR imaging • Meniscus repair • Anterior cruciate ligament reconstruction • Postoperative

KEY POINTS

- MR imaging is able to depict the normal and abnormal postoperative appearance of patients who have undergone meniscus surgery, ligament reconstruction, and cartilage repair.
- Understanding the options of repair, resect, or replace for meniscal surgery is key to the interpretation of postoperative knee MR imaging.
- A practical approach to the evaluation of MR images in patients who have undergone cartilage grafting includes a description of defect fill, integration, subchondral bone, repair tissue character, and non–repair site complications.
- MR imaging can be used to evaluate graft placement and integrity in patients following ligament reconstruction, aiding in the diagnosis of graft complications such as tear, impingement, instability and perigraft fibrosis.

INTRODUCTION

Orthopedic surgical interventions in the knee, including ligament reconstruction, meniscus repair and resection, as well as cartilage repair, transplant, and augmentation, occur with increasing frequency. Specifically, arthroscopic (partial) meniscectomy is the most commonly performed orthopedic procedure in the United States.[1] Although often successful, these procedures can result in short-term and long-term morbidity requiring postoperative imaging and subsequent further intervention. In a typical musculoskeletal imaging practice, postoperative examinations of the knee are performed on a daily basis with magnetic resonance (MR) imaging being one of the most commonly performed and most useful modalities in diagnosing recurrent disorders and directing further treatment.

This article reviews the normal and abnormal postoperative imaging appearance of frequently performed surgical procedures of the meniscus, articular cartilage, and ligaments. Imaging algorithms and protocols are discussed with particular attention to MR imaging techniques. Attention is paid to understanding the surgical procedure performed and the expected postsurgical appearance as well as commonly identified recurrent and residual disorders and surgical complications.

MENISCUS

The meniscus is a C-shaped fibrocartilaginous structure that functions to maintain joint congruity and stability while converting and distributing force applied to the knee to avoid injury. Thick, circumferentially oriented collagen fibers are interwoven with radial fibers to provide tensile strength and the ability to distribute force. Compared with hyaline cartilage, the meniscus has a higher collagen, lower proteoglycan, and lower water content.[2] However, zonal variations are present

Disclosure: The author has nothing to disclose.
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Radiol Clin N Am 54 (2016) 931–950
http://dx.doi.org/10.1016/j.rcl.2016.04.011
0033-8389/16/$ – see front matter

depending on the function of different parts of the meniscus; the thicker periphery of the meniscus functions to absorb tensile load and has low proteoglycan content, whereas the free edge absorbs compressive forces and has high proteoglycan content.[2,3]

The vascular supply of the meniscus is directly related to its ability to heal. With respect to vascularity, the meniscus is divided into a red or vascular peripheral zone and a white or inner avascular zone. The red zone tears can be expected to heal with a significantly higher rate compared with white zone tears.[4] White zone tears rarely heal and are more often treated with partial resection as opposed to repair. Tears between these two zones are termed red-white tears and do not heal at nearly the same rate as red zone tears.[5]

Meniscus injury is one of the most common causes for knee pain and tears of the meniscus are a leading reason for patients to undergo arthroscopy. Post–meniscus surgery pain, whether new or residual, can have several causes and often leads to referral for repeat MR imaging. Before attempting to interpret the postoperative meniscus on knee MR imaging, clinicians need to have a thorough understanding of the different meniscus surgical interventions; namely the concept of repair, resect, or replace. Knowledge of which of these three was performed as part of the pre–MR imaging clinical information is very important. Availability of the surgical report detailing the type of surgery performed, although not always available, along with the preoperative MR imaging, allows an ideal evaluation of the postoperative MR imaging.

POSTOPERATIVE MR IMAGING PROTOCOL FOR EVALUATION OF THE MENISCUS

There remains some debate in the literature as to the ideal techniques and protocols to evaluate the postoperative knee.[6–11] The techniques include conventional MR imaging, indirect MR arthrography, direct MR arthrography, as well as computed tomography (CT) arthrography. Although some research shows an overall increase in accuracy of MR arthrography compared with other techniques, a prospective study by White and colleagues[12] showed no statistical significance in these differences. For this and other reasons, in our practice, and anecdotally in most other practices, conventional MR imaging is used with 3 planes of intermediate-weighted fast spin-echo sequences along with 2 planes of fat-suppressed T2-weighted or short tau inversion recovery (STIR) sequences. However, MR arthrography is used for troubleshooting in difficult or confusing cases, or on specific request. CT arthrography is used for patients who cannot undergo MR imaging.

MR IMAGING APPEARANCE AFTER MENISCUS REPAIR

Meniscus repair is typically indicated for peripheral or red zone tears that are longitudinal in orientation and in younger patients, typically 40 to 50 years old and younger. These tears are often larger than 1 cm as tears smaller than this have been shown to heal spontaneously.[4,13,14] Three major techniques are used to repair the meniscus: inside out, outside in, and all inside. Various alterations of these techniques, with or without the use of biologic augmentation, are used in modern clinical practice with the specifics of these operations beyond the scope of this article.

- The criteria for a meniscus tear (abnormal signal and/or morphology) are the same for evaluation of the repaired meniscus but are less accurate compared with preoperative knee MR imaging.[15]
- The MR appearance of a successfully repaired meniscus should ideally show resolution of the previously identified bright signal abnormality as well as maintenance of the normal meniscus size and morphology (**Fig. 1**). The degree of healing can be classified as partial if there is bright signal extending into less than 50% of the tear site (**Fig. 2**).[2]

Fig. 1. Sagittal T1 fat-suppressed MR arthrogram after repair of a posterior horn tear shows minimal patchy intermediate signal abnormality (*white arrow*) with a normal size and shape of the meniscus and no bright signal gadolinium entering the meniscus, confirming a healed tear.