Meniscal problems: to repair and to replace

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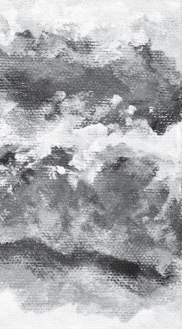
General introduction



GENERAL INTRODUCTION

In 2018 approximately 49.500 patients in the Netherlands were diagnosed with osteoarthritis (OA) of the knee by their general practitioner.[1] The risk of developing knee OA is increased compared to the general population in people after any knee injury,[2] where meniscal tears are the most common type of knee injury.[3] Meniscal tears are also common among asymptomatic uninjured knees and its prevalence increases with age.[4] These tears can often be painful causing a locking or giving way sensation of the joint, therefore require surgery, which usually involves either meniscal repair or meniscectomy.

Arthroscopic surgery of the knee is one of most common types of knee surgery with an estimated 27.500 procedures per year in the Netherlands. In the majority of cases, an arthroscopic partial meniscectomy is performed.[5] The unfortunate effects of this surgery, in addition of the damage of the meniscal tear itself, are loss of meniscal function, with subsequent higher stresses between the cartilage of femur and tibia during loading.[2,6] For that matter, successful arthroscopic meniscal repair surgery has compared to partial meniscectomy not only better patient outcomes, but also has fewer complications at long-term follow-up.[7] The latter is most notable by a reduced incidence of osteoarthritis of the knee.[8] Although an arthroscopic partial meniscectomy adds to the risk for the development of knee osteoarthritis, one must realize that the meniscal tear itself is a potent structural risk factor for the development of radiographic OA.[9] This highlights the need for better understanding, prevention, and treatment of meniscal tears.

MENISCAL FUNCTION

The meniscal function include loadbearing, shock absorption, joint stability, joint lubrication, and proprioception. It is has been known for decades that both medial and lateral menisci have important biomechanical functions within the knee joint, and that these functions are to be maintained. The latter was one of the reasons to start partial meniscectomies after the introduction of knee arthroscopies in the early 70s. Meniscal function, lack of function of torn menisci and deteriorated function after (partial) meniscectomy, as well the historical treatment options are discussed in **Chapter 2**.

MENISCAL REPAIR

The goal of meniscal tear treatment is to preserve as much meniscal tissue as possible. This means, repair the meniscus whenever possible. Most meniscal repairs were traditionally performed in the so-called red-red or the red-white zone because of the vascular

supply, where "red" is depicted as the area at the capsular side of the meniscus were blood vessels enter.[9] These "red" zones were found to be associated with a high likelihood of meniscal healing after repair or injury.[11,12] Other factors determining the success of meniscal repair are shape and length of the meniscal tear, quality of the remaining meniscal tissue and presence of concomitant anterior cruciate ligament injuries.[13,14]

Medium and long-term results of meniscal repair have shown to be successful, with an overall rate of failure (i.e. meniscectomy) of 20% to 24% at 5 years and at 10 years up to 27 to 30% of failures.[15-17] The use of newer meniscus repair techniques (e.g. biomaterials, all inside devices) as well as better patient selection and rehabilitation protocols improved this success rate even further.[18] Survival of meniscal repair depends on knee stability, which is determined by integrity of the "repaired" meniscus as well as ligamentous stability.[19] In unstable knees there is a decrease in the success rate of the meniscal repair with a variety of outcome of 30-70%. If the injured anterior cruciate ligament is reconstructed in conjunction with meniscal repair, the success rate of the meniscal repair is above 90%.[20] Lateral meniscal repairs are expected to heal better compared to medial meniscus repairs.[21]

The optimal time window between the occurrence of a meniscal tear and the meniscal repair as well as until which age this can be done are still controversial. Data on the time interval between the moment of injury and the actual meniscal repair and survival after the meniscal repair are scarce.[22-25] With advancing age, meniscal tissue becomes degenerative (e.g. less elastic, decreasing vascularity) which will have an effect on the healing response after repair. For that matter, chronic tears (existing more than 12 weeks) have a longer period of decreased vascularity and may lead to a lack of tissue vitality over time.[26] In **Chapter 4** a retrospective study was performed to evaluate the failure rates (e.g. revision surgery), patient reported outcome measurements and complications of arthroscopic meniscal repair in relation to the chronicity of the meniscal injury.

Not all meniscal injuries require surgery. When surgery is likely to benefit the patient, certain factors should be assessed to determine whether meniscal repair rather than (partial) resection is the most optimal option for that specific patient. Preoperative knowledge about the reparability of a meniscal tear is one the important steps in the management of meniscal tears. The latter is important in the shared decision making with the patient on his or hers most optimal treatment. Furthermore, it is also important, in case of a surgical repair, what the postoperative management should be, finally it helps surgeons in scheduling the most optimal time for this surgery.

If surgery is decided, intraoperative criteria for the success of the meniscal repair are based on factors like tear length, tear instability and tear type.[27] Magnetic Resonance Imaging (MRI) is the routine modality to evaluate the extend of injuries of the meniscus with a 84-93% sensitivity for medial meniscal injuries and a 70-79% sensitivity for lateral meniscal injuries, and a specificity of 88-94% and 94-96%, for medial and lateral meniscal

injury respectively.[28,29] But, using MRI to predict reparability of the torn meniscus is far less established. The tear length of longitudinal or bucket handle tears, the distance from tear to meniscosynovial junction and minimal damage are considered important parameters for meniscal repair.[27,30] However, these three established criteria on reparability were never externally validated in different large studies, nor was intraobserver and interobserver agreement tested. In **Chapter 3**, we performed an observational study to determine intra- and interobserver agreement on meniscal reparability for longitudinal, peripheral meniscal tears based on MRI findings by both orthopaedic surgeons and musculoskeletal radiologists.

As discussed earlier, the aim of meniscus repair is to prevent OA of the knee at the long-run[7] and since patients with a traumatic meniscus injury are often young (mean age < 35 years), they are likely to develop OA after 15-20 years, especially when not having their meniscal tears repaired.[31] To prevent the increase of contract pressure on articular cartilage after a meniscal tear, meniscal repair can be performed to restore its anatomy and function. Once a repairable tear is left untouched or partial meniscectomy is performed the development of OA can be prevented or delayed by decreasing the load on the articular cartilage by a modality such the interposition of an meniscal allograft. All to prevent these patients from a symptomatic meniscus deficient knee or, even worse, knee arthroplasty at a young age.

MENISCAL ALLOGRAFT TRANSPLANTATION

When meniscal repair is not possible or failed, partial resection of the meniscus is an option. However, partial meniscectomy can lead to further meniscal deficiency, which implies a decrease of surface contact area with subsequent increase of contact pressure, leading to wear and gradual disappearance of cartilage within a decade.[32-36] As mentioned earlier up to 30% meniscal repairs fail and still some patients require subtotal or even total meniscectomy. Joint degeneration after partial or (sub)total meniscectomy has been described very well.[37] Before signs of degeneration start, patients with a history of (sub)total meniscectomy, can suffer from pain localised to the meniscus deficient compartment. In these cases, meniscal allograft transplantation (MAT) is a viable option for these patients and can result in pain relief and improvement of function. The basic principle underlying MAT is to restore joint anatomy and thus biomechanics by relocating an allograft implant that will serve and perform in a similar fashion as the original one. Limitations to musculoskeletal donor tissue as well as donor age contribute to the shortage of available allograft meniscal tissue, but also to adequate anthropological parameters which fit the acceptor. The latter as well the strict criteria for meniscal transplant indications as such in selected

patients, leads to very few meniscal allograft transplantations each year. This is the reason, that in the Netherlands only two to three orthopaedic surgeons perform this.

MAT can be performed by an open and by an arthroscopically assisted procedure. Since the first open MAT[38] in 1984 many papers have been published regarding different aspects of it, including: indications and contraindications,[39] preoperative graft sizing,[40] graft preservation methods,[41] surgical techniques,[42] allograft fixation,[43] associated chondral and ligamentous damage relevance,[44] concomitant procedures,[45,46] histologic evaluation,[47] clinical and radiographic outcomes,[48-50] and rehabilitation.

Ideally, MAT should delay, or even better prevent, development of severe, symptomatic OA of the knee. The only randomised trial in this field comparing MAT versus personalised physiotherapy for patients with a symptomatic meniscal deficient knee compartment showed clinical superiority at very early, 12 months, follow-up. Even more, that study did not evaluate radiological changes throughout follow-up, or any other effects on the cartilage as such.[51] Despite these studies and the claimed chondroprotective effect, which was shown in a small sheep study (n=45),[52] the chondroprotective effect in humans remain unclear.[49,53]

Concerning the development of OA changes in subchondral bone play a key role in the pathogenesis and progression of OA.[54-58] Subchondral bone changes can be considered both a result and a cause of cartilage damage and cartilage loss.[57,59]

Interestingly, no study evaluates the impact of the history of knee problems and interventions in the years prior to a MAT on patient ‘s life. The sequel of this not only on the patient’s clinical burden, but more over on his or hers daily life activities should be of interest to any clinician These factors will influence the perceived outcome after MAT

OUTLINE OF THE THESIS

This thesis is divided into two parts. The first part of this thesis focuses on meniscal tears and repair. Additionally, this part is focussed on meniscal reparability based on MRI findings and evaluates clinical survival of meniscal repair. The second part of this thesis is focuses on meniscal allograft transplantation. Clinical results of both open and arthroscopically assisted MAT are presented. A Dutch meniscal patient reported outcome measure (PROM) is translated and culturally adapted.

The aims of this thesis were:

1. To provide an overview of meniscal function, effects of meniscal deficiency and (historical) treatment options.
2. To evaluate of meniscal tears
   - Clinically: meniscal repair survival in relation to chronicity of injury
   - Radiologically: meniscal reparability for longitudinal, peripheral meniscal tears

3. To evaluate the clinical outcome of a long-term retrospective cohort of patients having an open MAT
4. To evaluate a novel instrument (Dual-energy X-ray Absorptiometry (DXA)) to gain more insight in the potential chondroprotective effect of MAT.
5. To evaluate patient reported outcomes (PRO), survival of meniscal allograft and the history of MAT patients with respect to knee complaints, interventions and social impact prior to meniscal allograft transplantation is evaluated.
6. To translate and culturally adapt a meniscal specific patient reported outcomes measures (PROM) to evaluate meniscal pathology and its treatment

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