Progress towards understanding anterior knee pain after total knee arthroplasty
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Chapter 12

General introduction

The main goal of a total knee arthroplasty (TKA) is to relieve pain and restore function in a severely diseased or injured knee joint. Although many improvements have been made in surgical techniques and implant design, knee arthroplasties are not able to fully restore a knee to its pre osteoarthritis or pre injury state. However, numerous articles report success in improving quality of life by relieving pain and restoring function to a significant degree, and long-term survival of the arthroplasties. One major problem that remains is the proportion of patients continuing to experience varying degrees of pain after a TKA. The location of this persisting pain is usually in the anterior part of the knee. Not only is this pain bothersome, but it is also one of the reasons for an early revision surgery. In this thesis anterior knee pain (AKP) after TKA will be analysed and some clinical implications discussed.

This thesis is intended as a contribution to the process of better understanding AKP after TKA from a number of perspectives. Firstly, the issue of pain is addressed in a systematic review of pain transmission mechanisms and possible causes of anterior knee pain. Secondly, the issue of how to document the outcomes of TKA is addressed by looking at three English patient reported outcome measures (PROMs), which were translated and validated for use in the Netherlands. Two of these are general outcome measures for knee function and one is specifically for anterior knee pain. Thirdly, TKA design issues are discussed. It has been postulated that a mobile bearing TKA may have certain advantages over a fixed bearing TKA. One such advantage, a lower incidence of AKP, was evaluated in a double-blinded prospective randomised clinical trial. The fourth area addressed is placement of the TKA. As the self-alignment of a mobile bearing may be beneficial in reducing the incidence of AKP, the question arises how and to what extent the malposition of the tibial base plate is corrected by the mobile bearing. This was addressed by a CT-based measurement of component positions in patients with a mobile bearing TKA. Finally, currently used outcome measures do not assess cycling. Since cycling is an activity that is especially relevant to the Dutch population, it is pertinent to consider what effect cycling may have on patients with a TKA and if cycling is a beneficial and recommended activity for TKA patients.
Chapter 2: What can cause anterior knee pain after a total knee arthroplasty? Since AKP is a frequently occurring complication after TKA, the primary need is to elucidate how pain transmission works, what causes the pain in the anterior part of the knee and what can go wrong with the nociceptive system after a TKA placement. In particular, it is important to identify what structures in and around the patellofemoral joint (PFJ) are sensitive to pain. These issues were addressed in a narrative review of the current literature.

The synovium, retinaculum, the infrapatellar fat pad, periosteum and subchondral bone of the patellae are all richly supplied with type IVa Free nerve endings (FNEs) and fibres containing Substance P. Assuming that incapacitating AKP is caused by the activation of FNEs, the key is to know how they become active and whether this is due an abnormal mechanical deformation, thermal stimuli or special chemical agent. Several publications support the hypothesis that anything that is able to change the mechanics of the PFJ can activate these FNE and thus induce AKP after TKA. The nociceptive system seems to be able to be activated by several factors, either alone or in combination: Hoffa impingement, peripatellar synovitis, increased osseous pressure, patellofemoral instability and mechanical changes that alter the PFJ in an abnormal way. Anterior knee pain after TKA can thus be seen as the presenting symptom of a multifactorial problem. The literature agrees in broad terms that the nociceptive system is being activated by abnormal mechanical deformation, thermal stimuli or special chemical agents and the the pain seems to be caused by soft tissues (i.e., retinaculum, infrapatellar fat pad and the synovial membrane) being overloaded and/or due to impingement; for example due to malrotation of the components, overstuffing of PFJ, instability of the PFJ or a combination. Simply changing to a mobile bearing, releasing the retinacula or resurfacing the patella does not seem to be a universal solution. A perfect placement of a well-designed TKA can minimise AKP, however it cannot be concluded that it will prevent AKP, due to the large number of different factors playing a role in the origin of AKP.

Chapter 3-5: Documenting outcomes, how is AKP and success evaluated for (Dutch) TKA patients?

The goal of these three studies was to describe the results of the translation and the testing of the validity and reliability of three internationally accepted patient reported outcome measures for the Dutch population. These studies
included patients with osteoarthritis, both those who will undergo and those who had already received a knee arthroplasty. 

In 1998 the Oxford 12-item Knee Questionnaire was developed by Dawson et al as a self-administered disease and site specific questionnaire, especially developed for knee arthroplasty patients. Since then it has proven to be an effective outcome questionnaire, and is widely used. Despite the positive psychometric properties for the Total Knee Arthroplasty (TKA) population, the 12-item knee questionnaire has only been translated in a few languages. We thus translated and validated the Oxford 12-item knee questionnaire for the Dutch population. After translation according to a forward/backward protocol, 174 knee arthroplasty patients were asked to fill out the questionnaire together with an SF-36, an AKSS and a VAS. The reliability, validity, content validity and the sensitivity to change were all tested. The Dutch version of the Oxford 12-item knee questionnaire achieved excellent scores in all of these properties. The ICC of the questionnaire was high at 0.97. Crohnbach's alpha showed that the questionnaire had a strong internal consistency, with values of 0.87 and 0.90 preoperatively and at 1-year follow-up, respectively. The Dutch Oxford 12-item knee questionnaire proved to be an excellent evaluation instrument, being reliable, valid and highly sensitive to change and can be used for all knee arthroplasty patients.

In 2001 the International Knee Documentation Committee (IKDC) presented a knee specific subjective outcome measurement tool. The IKDC subjective knee form was designed to measure symptoms and limitations in function and sports activity due to impairment of the knee for every knee related injury. After a forward-backward translation protocol, the reliability, validity, and content validity were tested. The responses of 145 consecutive knee patients to 2 questionnaires were used. These contained the Short Form-36 (SF-36), Western OntarioandMcMasterUniversitiesOsteoarthritisIndex(WOMAC), Oxford12-item knee questionnaire score, a visual analog scale, and the Dutch IKDC Subjective Knee Form. Reliability was tested by measuring the test-retest reliability and internal consistency. Validity was tested by correlating the questionnaire to the other outcome measurements, and content validity was tested by measuring the floor and ceiling effects. The reliability proved excellent with an intraclass coefficient of 0.96 for test-retest. Internal consistency was strong (Cronbach's Alpha 0.92). The construct, convergent, and divergent validities were good. The content validity was good; no floor or ceiling effect occurred in the selected
patient group. Our results showed that the Dutch version of the IKDC Subjective Knee Form is an excellent outcome measurement tool for knee-related research for all knee related injuries. However, for osteoarthritis of the knee, the Oxford 12-item knee questionnaire score was shown to have better construct validity. Although the general knee questionnaires included pain questions, they were not specifically developed to detect AKP. Even with good to excellent scores on these questionnaires, patients can still suffer from AKP. Therefore conclusions regarding AKP after TKA should not be made based on these questionnaires. The Kujala score, also called the Anterior Knee Pain scale (AKPS), is a validated tool to evaluate AKP. The translation and validation of the Kujala AKPS for AKP in Dutch knee arthroplasty patients makes it possible to adequately follow up these patients and monitor AKP before and after surgery. The internal reliability of the AKPS is acceptable with a Cronbach’s alpha of 0.81 in patients after TKA or UKA. A high correlation was found between the AKPS and the Oxford 12-item questionnaire (R = 0.81). Moderate correlations were found with the VAS ‘last month’ (R = 0.63), HSS patella score (R = 0.51) and SF-36 subscales physical functioning (R = 0.59), role-physical (R = 0.59), bodily pain (R = 0.57). Other correlations were poor, therefore indicating a good convergent and divergent validity. The AKPS can be used to assess complaints of AKP in patients following knee arthroplasty and to evaluate effectiveness of certain treatment options like isometric training programs or secondary patella resurfacing, on complaints.

Chapter 6-7: Has a mobile bearing TKA advantages over a fixed bearing TKA in relation to the solving of the AKP problem?
These two chapters specifically address the effect of a mobile bearing design on AKP by comparing the posterior stabilised mobile knee (PSM) with the posterior stabilised fixed knee (PS). The theoretical advantage of the mobile bearing TKA is the ability to self align, and therefore to accommodate small mismatches. If this is actually the case, a better patellar tracking can be expected with a decrease in the incidence of anterior knee pain. The secondary questions are whether one design was superior to the other regarding overall pain, function, quality of life and survival. The studies were performed as a prospective, randomised, double-blinded, clinical trial. After one year there was statistically less anterior knee pain in the PSM knees compared to the PS knees. Although the overall outcome (overall pain, function, quality of life and survival) between the PSM and PS bearing did not differ, the data show that the presence of anterior knee pain...
significantly influenced the outcome of the TKA and therefore can be considered clinically relevant. On the longer term, i.e. about 8 years postoperatively, the most important outcome is that a PSM knee does not give a lower incidence of anterior knee pain compared to the PS knee. Most systematic reviews and/or meta-analysis do not show an advantage of using a mobile bearing. Following a recent meta-analysis showing less AKP in the mobile bearing TKA, it seems that the debate is open again as to whether the mobile bearing is part of the solution to AKP. Other authors have suggested that the performance of a mobile bearing knee might decline over time. Even if this observed difference is only relevant during the first years after the surgery, still for those patients that experience less pain in this period it seems worthwhile to use a mobile bearing TKA.

Chapter 8: Can a mobile bearing correct for malrotation of the fixed tibial base plate after TKA?
The question is whether a mobile bearing can correct the malrotation of the fixed tibial base plate in a PSM TKA. This question is addressed by performing a Computed Tomography evaluation of the TKA, measuring the component rotations relative to the bones in a selected group of patients. The key issue is whether the corrective rotation of the mobile PE is correlated with the malrotation of the fixed tibial base plate. Previously it was reported that a combined internal rotation had a relative risk of AKP, which was five times higher than those without combined component internal rotation. It is thought that a femoral component placed in internal rotation shifts and tilts the patella medially and that this can have a negative influence on PFJ. This could be an important reason to explain why secondary resurfacing of the patella does not always solve AKP after TKA.

This study showed that the PE-component of the mobile bearing TKA corrects for malrotation of the fixed tibial base plate. When the tibial base plate is internally rotated, the PE bearing will turn more towards external rotation, bringing the rotation of the combined components back towards neutral position.

Chapter 9: A revision operation for anterior knee pain after a TKA can have consequences
A case report illustrates the consequences that post-operative AKP can have for a patient. It details a rare clinical history of an 81-year-old male with a recurrent
haemarthrosis after secondary resurfacing of the patella for treating persistent AKP. Additionally, there is a literature review and a discussion about aspects of haemarthrosis after a TKA. Though rare, vascular complications are reported in between 0.03% and 1.6% of patients undergoing a TKA. Early causes are direct arterial injuries, which can occur during the resection of the proximal tibia, distal femur, but also with pin fixation and while performing the necessary releases or the removal of the menisci. Arterial aneurysm, pseudoaneurysm and arteriovenous fistula tend to occur in the first few months after the operation, but can also present in a much later stage. Arterial aneurysm and pseudoaneurysm can present with a painful pulsatile mass, often posterior in the knee. However, presence of a thrombus can prevent the pulsatile feature to be present and therefore make the diagnosis difficult. The use of CT angiography and image guided therapy is advised to treat this complication.

Chapter 10: The influence of cycling on patients with osteoarthritis and knee arthroplasty
Cycling is a popular international professional and recreational sport enjoyed by both sexes and all age groups. Regular exercise is important for the elderly population and it has been shown that cycling is of great value for the osteoarthritis- and knee arthroplasty patients. The purpose of this study was to evaluate the predictors of cycle use in three groups of knee patients. 298 patients were included, 93 patients had osteoarthritis of the knee, 118 had received a total knee arthroplasty and 87 had a meniscal and/or ligamentous injury. The average age for the osteoarthritis of the knee group was 60.4 years, for the total knee arthroplasty group 71.9 years and for the meniscal and/or ligamentous injury group 42.3 years. Patients were evaluated at the outpatient clinic and asked to complete the SF-36, Oxford 12-item knee-, IKDC- questionnaire and a specific cycling questionnaire. As the patient gets older, the chances of being able to cycle, decrease by 5% every year. The chance to be able to cycle is 1.98 times higher for a male patient compared to a female patient. The chances of experiencing pain while cycling increases by 8% per unit rise of BMI. Age and sex, and not the clinical diagnosis are the predictors of the ability of a patient to cycle. An increased BMI is the only risk factor found for experiencing pain while cycling.
Chapter 12

General discussion

In the future, the development of biological joint arthroplasties may mean that TKA is better able to restore a pain free knee with a good function. For the present, however, patients need to understand that some anterior knee pain may be a persisting problem, and clinicians need to develop a better understanding of why this is and how to reduce its incidence and severity.

Patients judge the success of their TKA based on pain reduction and restored function. Measuring satisfaction and outcomes is nevertheless difficult, due to the many factors that play a role. For example, dissatisfaction may be a demonstration of an unrealistic expectation rather than a reaction to a poor outcome. An essential part of the treatment of TKA patients is therefore to enable them to form realistic expectations of the likely impacts and results. This can best be done prior to surgery through clear communication, education and the use of patient reported outcome measures (PROMs).

For clinicians it is important to understand that anything that is able to change the mechanics of the patellofemoral joint (PFJ) seems to activate FNE and thus induce AKP after TKA. This AKP is often the presenting symptom and can be considered as the tip of the iceberg. Patients complain of AKP after a TKA, and not about the malrotation or the instability that may be behind it. If AKP is present, surgeons should try to determine the underlying cause of this pain, which is often multifactorial.

This thesis suggests a number of ways to help determine the degree and type of AKP that may be present after a TKA placement. The Kujala score can be used to measure if AKP is present before and after TKA placement. Furthermore, the Kujala can be used to evaluate the effectiveness of treatment options used. If AKP is present CT scans can be used to determine if malrotation of the TKA components is a contributing factor.

This thesis also draws a number of conclusions about minimising AKP. It appears that when treating future patients, simply changing to a mobile bearing TKA will not necessarily solve the problem. However, it can have a positive influence on the presence of AKP, especially in the first postoperative years. Correct
placement of femur and tibia components is crucial and the mobile bearing can have a forgiving feature, provided it is placed the correct way. Moreover, just releasing the retinacula or resurfacing the patella does not always resolve the AKP problem. It can be concluded that a perfect placement of a well-designed TKA can minimise the chance of AKP, but it cannot be concluded that it will fully prevent it, as many factors are playing a role in the origin of AKP.

In conclusion, anterior knee pain remains one of the major problems patients experience after a TKA. The goal for the next decade is to make significant further progress in understanding the complex interaction of factors causing AKP in order to know how to prevent and eliminate it.