Progress towards understanding anterior knee pain after total knee arthroplasty

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Chapter 1

General introduction
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Introduction

Total Knee Arthroplasty (TKA) has been shown to be a successful procedure for treating patients with osteoarthritis. It is thought to have originated with Ferguson, who had some success with the resection of the entire knee joint in order to achieve a kind of pseudoarthrosis [23]. Though the knee displayed a good range of motion, the overall result was unsatisfactory, because there was instability, and in many patients a spontaneous fusion occurred [22]. The first to implant a total knee replacement was Gluck, a German surgeon, in 1890 [39,23]. The knee was made of ivory, which was fixed to the bone with colophony, pumice and plaster of Paris [39,41,23]. Despite being an outstanding innovation, this technique had a high failure rate due to infection and loosening, and it was quickly abandoned [39,41,23]. During the following 40 to 50 years, several soft tissue interpositions were used in order to try to prevent bone-to-bone arthritic pain. These included; fascia lata, fat, prepatellar bursa, skin, pig bladder and later cellophane and nylon [41]. The results were unpredictable, and arthrodesis remained the treatment of choice for the ‘moderately destroyed knee’ [41]. In the 1940s the first metallic interposition knee arthroplasties were used [41]. In the 1950s Dr. Waldius developed a hinged knee prosthesis made of acrylic, and later the first cobalt chrome knee prosthesis was implanted [39]. Due to the high failure rates of the hinged knee prosthesis, less constraint knee replacements were developed and became the standard treatment for primary arthritis knees [39]. Around the end of the 1960s and the early 1970s the condylar knee replacement as a joint resurfacing procedure was developed, and this evolved through numerous modifications to become the basis of the current TKA still in use today [39]. Though the initial success of TKAs improved, the focus was resurfacing the medial and lateral compartments, while little attention was paid to the patellofemoral joint [40]. Reports on the results of early designs identified a 40 to 58% rate of patellofemoral pain or Anterior Knee Pain (AKP) [12]. This residual knee pain was then treated with a patellectomy and/or soft tissue realignment [30]. Insall et al. in 1976 concluded that residual pain after a TKA was most frequently due to the patellar compartment, and that patellectomy was not a solution to this problem [30]. The continuing high incidence of postoperative AKP led to changes in the patellofemoral part of the TKA, such as modifying the shape of the trochlea of the femoral implant and placing a patella component [30,40].
In the early days of arthroplasty treatment, only patients with severe arthritis were operated on, and they were satisfied if they could sleep again and walk short distances, even if pain persisted. Any treatment was better than receiving an arthrodesis or to continuing with debilitating pain and severe limitations. Over the years, TKA has achieved better results, due to improvements in the quality of the products used, better instrumentation and improved surgical knowledge. Due to the considerable pain relief achieved and excellent longevity of the knee arthroplasty, with survival rates of 90-98% after 10-18 years, the number of TKAs is expected to increase in the coming years [11,17-18]. Not only are patients treated at a younger age, but also the general patient population is getting older. Today, more than 22,000 knee arthroplasties are performed annually in the Netherlands [32]. In the United States the number is estimated to be 658,000 annually [6].

Though TKA is very successful, approximately 5-10% of patients experience Anterior Knee Pain (AKP), with reports ranging from 0.4%-49% [2-5,9-10,12-13,21,25-27,35-36,40,44-46,48]. Multiple theories have been proposed to explain the aetiology of AKP [2-5,9-10,12-13,21,25-27,35-36,40,44-46,48]. Many studies have focused on the resurfacing of the patella, some demonstrating no difference [12-13,45], some showing better results after resurfacing [9,26,40,47-48], and others advising against resurfacing the patella [2,34,49]. It is known that simply resurfacing the patella is not a universal solution for AKP, although it may solve the problem in selected cases [2,12-13,25,34,40]. The consequences of postoperative AKP are not only the burden pain, but also the risk of a re-operation and the extra direct health care costs (for instance hospital stay, operation costs and costs of implants).

Other factors contributing to AKP have been proposed, either as sole cause or in combination; i.e. prosthesis design [30,45], malrotation of the components [3-5,27], wear [44], overstuffing the PF joint, changing the joint line [33], instability of the patella [21,36], soft tissues impingement [20], patient characteristics [10,25], dynamic valgus [38] and referred pain [44-45].

As mentioned earlier, various changes have been made to the TKA design. One such development was the introduction of the mobile bearing in the 1970s. It was thought that the higher congruency of the articulating surfaces could reduce wear and reproduce physiological knee kinematics, allowing it to be used in younger patients with a more active lifestyle [11,43]. Numerous studies have attempted to confirm the theoretical advantages of a mobile bearing TKA over a fixed bearing TKA, but most show few or no actual benefits. In a recent report...
from the New Zealand registries, it seems that the mobile bearing does not need to be resurfaced, in contrast to the fixed bearing PS (posterior stabilised), where the patella probably should be resurfaced \[49\]. There are some who think that, because the mobile bearing can self-align, it has, in theory, a better patellar tracking and thus might decrease the incidence of AKP. Apart from design, malplacement of the components seems to be an inducing factor for AKP, especially in case of an internal malrotation of the TKA components, where patella maltracking could lead to AKP \[3-4\]. Berger et al linked combined component internal rotation (the sum of internal rotation of the femoral component and internal rotation of the tibial component) of a fixed bearing TKA to patellar tilt, subluxation, dislocation and patellar component failure \[4\]. Barrack et al reported a correlation between AKP and component rotation following a TKA, and concluded that patients with combined component internal rotation were more than five times as likely to experience AKP compared to those with combined component external rotation \[3\]. In their study, Nicoll and Rowley indicated a threshold value of internal malrotation of the tibial component before patients are expected to experience pain \[37\]. Most studies reporting on internal malrotation focuses on the fixed bearing TKA \[3-4,37\]. The cases where there is a fixed tibial base plate malrotation, the effects of using a mobile bearing are not well known.

The numbers of knee arthroplasties being performed are anticipated to increase significantly \[6\]. Health care professionals will be expected to assess and record the outcomes of knee arthroplasty for patients, in order to facilitate research, audits and clinical governance. Suitable outcome measures are needed to enable evaluation of improvements in pain relief, function and QoL following a knee arthroplasty placement. Already in 1883, Lord Kelvin observed: “When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the state of Science, whatever the matter may be” \[28\]. Within groups of patients with a similar condition, outcome measures should allow comparisons to be made between preoperative and postoperative states, and between different operating techniques and types of arthroplasties. Furthermore, an outcome measure must have specific properties; it should be
reliable, valid and sensitive or responsive to changes in the clinical setting, and the questionnaire should be easy to use for the patient \[15\].

Measuring the outcome of knee arthroplasties used to be physician driven, where the surgeon scored pain and functional disability. This meant that the surgeon determined if an operation had an excellent, good, fair or poor result and little attention was paid to the patient’s own evaluation or to their expectations \[29\]. Survival analyses were and still are an important criteria for evaluating the results of TKA \[29\]. Yet, for patients, function improvement and pain relief are extremely, and perhaps more important success criteria. If a patient has a perfectly placed TKA and the radiograph looks great, but it does not function well or they experience pain, then the patient will not be satisfied with the TKA. In recent years the patient’s experience in relation to pain, function, impact on daily living and quality of life has attracted much attention. The value of patient input has been recognised with the introduction of patient related outcome measures (PROMs), derived from subjective questionnaires\[8\]. There are different PROMs available: some are for general health assessment and others are joint/disease specific \[8,16,42,19\]. The choice of which questionnaire is most appropriate depends on what it is supposed to be measuring in a specific population \[15\]. For the majority of patients the most important reason to place a TKA is to reduce or eliminate pain in their knee joint, thereby preserving or restoring a certain level of function \[16,19,42,22\]. If the pain persists after TKA, it is a major contributor to patient dissatisfaction \[22\]. Therefore, not surprisingly, pain is one of the key parameters for evaluation in most questionnaires in current use. However, some merely ask if pain is present, while others explore the level and type of pain. Other important parameters covered in most questionnaires are function and quality of life. Again, there are differences in the level of detail they explore. When selecting one or more questionnaires to use for arthritis and TKA patients, it is important to determine if the questionnaire fits the population it is used on. Young or active patients are more likely to score highly, in terms of what they are able to do, than the older or less active patients. Not being able to question about a bigger range of activity or pain level is called the ceiling effect. Extending the ceiling, by giving patients more options to choose from, makes it possible to differentiate more effectively between patients with, for example, slight or severe pain and an active or less active life style. This helps the surgeon make the most appropriate choice for a specific patient in terms of technique and /or implant to be used.
Another issue is the lack of a reliable and valid questionnaire to adequately assess the type of knee pain following knee arthroplasty. Current questionnaires do not adequately assess AKP in terms of where and when the pain is experienced and what effect it has on a patient’s daily life. Researchers without a suitable PROM in their own language have two choices; either develop a new measure, or adapt a measure previously validated in another language. This validation and translation process is known as cross cultural adaptation. The option of developing a new questionnaire is time consuming and has the potential drawback of making international knee related research more difficult or impossible, if different measurements cannot be compared. However, according to Guillemin, translating a questionnaire is unlikely to be successful, due to differences in language, perceptions of quality of life (QoL) and culture. Beyond linguistic translation, there needs to be testing and validation to ensure a questionnaire can be used to achieve the same goals. Some cultures may be sufficiently similar for this not to be a problem; for example, the absence of major cultural difference between the Dutch and American/British populations means no cultural adaptation is needed for questionnaires. On the other hand, special adaptation would be needed if the questionnaire is intended to be used for populations with significantly different cultural and religious backgrounds, where, for example, kneeling activities are more frequent, like in Asian and Islamic cultures.

Today, patients with knee arthroplasties are no longer satisfied with ‘only’ being pain free and able to walk. Most patients want to be active and enjoy recreational activities and/or sports. The question remains; what are recommended ‘safe’ sports for patients after TKA and other knee conditions? Cycling is a popular international professional and recreational sport performed by both sexes and all age groups. The knee forces of cycling are much lower than during normal walking. It is estimated that 49 million Americans cycle at least once a month and over 5 million cycle more than 20 days a month. In the Netherlands there are almost as many people who own a bicycle, as there are inhabitants. The bicycle is not only used for sporting activities, but also for recreation and getting around. In the Netherlands cycling is the third most used means of transportation, after the car and walking. It would be interesting to know what factors influence the patient’s ability to cycle, and what percentage of patients still cycle after TKA placement.
Greater progress towards understanding the contributing factors of AKP after TKA can play an important role in improving the overall patient satisfaction and quality of life. Therefore this thesis aims to address several questions:

- How does pain transmission work in the knee and what can cause this pain in the anterior part of the knee?
- How is outcome and AKP documented in Dutch TKA patients?
- What is the effect of a mobile bearing TKA on AKP as compared to a fixed bearing TKA?
- Does a mobile bearing TKA correct for malrotation of the fixed tibial base plate after TKA placement?
- What is the influence of cycling on arthritis- and TKA patients and is cycling a recommended activity for TKA patients?

Outline of the thesis:

Chapter 2: Anterior Knee Pain after a Total Knee Arthroplasty: What can cause this pain?

This chapter is a review of what is thought to cause Anterior Knee Pain (AKP) after a Total Knee Arthroplasty (TKA). AKP is a serious problem for some patients after TKA. It is important to identify the different anatomical structures that can cause this pain before developing strategies for its prevention. This chapter reviews how pain transmission works, and what can cause pain in the anterior part of the knee and what can go wrong with the nociceptive system after a TKA placement. In particular it will seek to identify what structures in and around the PFJ are sensitive to pain, what receptors and/or chemicals are responsible for pain transmission and under which circumstances nociceptors become active.

Chapter 3-5: How is outcome and AKP documented in Dutch TKA patients?

These chapters describe the results of the translation, validity and reliability of three internationally accepted patient reported outcome measures for patients with arthritis, including those who will undergo or 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\textsuperscript{16}. Since then it has proven to be an effective outcome questionnaire, and is widely used\textsuperscript{19}. Despite having positive psychometric properties for the Total Knee Arthroplasty (TKA) population, the Oxford 12-item knee questionnaire has only been translated in a few languages. Chapter 3 describes the translation and validation of the Oxford 12-item Knee Questionnaire for the Dutch population. The reliability, validity, content validity and the sensitivity to change were all tested.

In 2001 the International Knee Documentation Committee (IKDC) presented a knee specific subjective outcome measurement tool\textsuperscript{31}. 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\textsuperscript{31}. A validated Dutch version of the IKDC Subjective Knee Form is important for knee related research and could be a very useful measurement tool in performing multinational studies and comparing results to international research. Chapter 4 describes the process of translation and validation of the IKDC subjective knee form.

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. A reliable and valid questionnaire is clearly needed to adequately assess the problem of AKP in patients following knee arthroplasties. The Kujala score, also called the Anterior Knee Pain scale (AKPS), is a validated tool to evaluate AKP. Chapter 5 describes the translation and validation process, of the Kujala AKPS for the Dutch population.

Chapter 6-7: Has a mobile bearing TKA advantages over a fixed bearing TKA in relation to the solving of the AKP problem post operatively? These two chapters specifically address the effect of a mobile bearing design on AKP by comparing the posterior stabilized mobile knee (PSM) with the posterior stabilized fixed knee (PS). The concept of self-alignment led to the hypothesis that the PSM leads to: a lower incidence of AKP than the PS knee. 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, randomized, double-blinded, clinical trial. Chapter 6 describes the evaluation of the short-term results of the PSM knee,
compared to the PS knee TKA. Chapter 7 address the question whether the outcome at the short-term follow-up persists at a longer term, i.e. about 8 years postoperatively.

Chapter 8: Can a mobile bearing correct for malrotation of the fixed tibial base plate after TKA?
The purpose of this chapter is to evaluate if a mobile TKA can correct the malrotation of the fixed tibial base plate in a PSM TKA. This evaluation is performed with Computed Tomography. The focus of this chapter is whether the corrective rotation of the mobile PE is correlated with the malrotation of the fixed tibial base plate.

Chapter 9: A revision operation for anterior knee Pain after a TKA can have consequences
This chapter presents an example of the consequences that post-operative AKP can have for a patient. It details a rare case report 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.

Chapter 10: The influence of cycling on patients with arthritis and knee arthroplasty
It is well known that cycling can play a role in maintaining general health and preventing further degeneration and TKA wear for patients wishing to be active. This is because knee forces during cycling are lower compared to normal walking. This chapter is included to determine in three groups of knee patients (arthritis, TKA and meniscal/ligamentous injury) how frequently patients cycle and whether they experience pain when cycling. Furthermore whether a prediction can be made about the ability of a patient to cycle, and what influences this ability.

To achieve a well functioning and pain-free TKA greater attention to and understanding of AKP will lead to better results and overall patient satisfaction after TKA.


Chapter 1

References

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