Progress towards understanding anterior knee pain after total knee arthroplasty

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Chapter 10

The important predictors of cycle use in three groups of knee patients

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Abstract

Purpose:
Cycling is a popular international professional and recreational sport performed 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.

Methods:
We included 298 patients, 93 patients had osteoarthritis of the knee, 118 received a total knee arthroplasty and 87 had a meniscal and/or ligamentous injury. Patients were evaluated at the outpatient clinic and asked to complete the SF36-, Oxford 12-item-, IKDC- questionnaire and a specific cycling questionnaire.

Results:
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.

Conclusion:
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.

Keywords: knee, cycling, pain, osteoarthritis, meniscal injury, ligamentous injury, Total Knee Arthroplasty.
Introduction

Cycling is a popular international professional and recreational sport performed by both sexes and all age groups \(^[3,6,10,13,12,2]\). It is estimated that 49 million Americans cycle at least once a month and over 5 million more than 20 days a month \(^2\). In the Netherlands there are almost just as many people who possess a bicycle as there are inhabitants \(^3\). The cycle is not only used for sporting activities but also for recreational activities and as a means of transportation. In The Netherlands cycling is the third most used means of transportation after the car and walking \(^3\).

It is well known that regular physical exercise is important for the elderly population and it has been shown to reduce anxiety, depression, all-cause mortality, and to improve cardiopulmonary health \(^{10,12}\). Other important positive effects are weight loss, an increase of bone density, and improved muscle co-ordination \(^{10,12}\). Although regular exercise is advised, pain can prevent patients from performing their daily activities and sports. The decrease in daily activities and/or sports leads to lower muscle strength and endurance, which again decreases daily activities and/or sports, resulting in a vicious circle. Pain with exercise and decrease in muscle strength make patients insecure to cycle and afraid of falling. Another contributing factor could be their possible co-morbidities, like cardiopulmonary disease, impaired hearing, dizziness, limited power of vision and many other reasons. Older people or patients seem to adapt their lifestyle to their limitations and would rather take the car or public transport.

Total Knee Arthroplasty (TKA) has become the generally accepted treatment for severe osteoarthritis of the knee, relieving pain and improving function \(^{6,10}\). The clinical success of TKA has been well documented, therefore, our patients expect to continue an active lifestyle \(^{10,12}\). In recent years the recommended ‘safe’ sports for patients after Total Knee Arthroplasty and other knee conditions were published \(^{10,13,12}\). Ericson and colleagues performed several studies on the biomechanics of cycling and found that the mean tibio-femoral compressive force was 1.2 times body weight (BW) when participants were cycling at 60 rpm with a workload of 120 W \(^7\). D’Lima et al estimated even lower values \((1.02 \text{ times the BW})\) in their in-vivo knee force study during recreational cycling \(^4\). Therefore, the in vivo knee forces of cycling \((+/-\ 1 \text{ times the BW})\) are much lower than the in vivo knee forces during normal walking \((2.8-3.5 \text{ times BW})\).
when walking +/- 5 km/h) [7]. The low-impact of cycling on the knee joint makes cycling one of the most important activities recommended for osteoarthritis- and TKA patients [4,10,13,12].

Literature, but also our own clinical experience, shows that being able to cycle or to resume cycling is important to many patients [10,12]. The purpose of this study is to investigate the ability to cycle in three groups of knee patients.

**Materials and Methods**

Between February 2004 and March 2005, 400 consecutive patients were asked to participate at the outpatient clinic of the Orthopedic departments of an Academic and a general hospital. All patients who consulted us for disorders of the knee were asked to participate. The exclusion criteria were (1) inability to understand and speak Dutch language and (2) being unable to fill out the response forms. A participation request was accompanied by a response form and a postage-paid return envelope. The request included a letter with instructions and information about the research question. If a patient agreed to participate, he/she filled out a set of questionnaires that contained the Short-Form 36 (SF-36), Oxford 12-item knee questionnaire, International Knee Documentation Committee (IKDC) questionnaire and specific questions regarding cycling. The non-responders were reminded by telephone. If a non-responder did not return the questionnaire after this reminder-call, he was not contacted again.

The Short-Form 36 (SF-36) is a self-administered generic health related quality of life (HRQoL) questionnaire constructed for use in medical outcomes studies [6,8]. It contains 36 questions on eight scales: physical function, role limitations because of physical health problems, bodily pain, social functioning, general mental health, role limitations because of emotional problems, vitality and general health perceptions [6,8]. The score ranges from 0 to 100, in which 0 is the worst score and 100 the best possible score. The International Knee Documentation Committee (IKDC) Subjective Knee Form was first published in 2001 [11]. It is designed to evaluate a variety of knee conditions, including ligament and meniscal injuries [11]. The IKDC was translated and validated into many different foreign languages, including Dutch [9]. The Oxford 12-item questionnaire is a knee-specific questionnaire; every item has a score from 1
to 5 (from less to most difficult or serious) and a total score with a range from 12 to 60\textsuperscript{[6,8]}.

The specific questionnaire regarding cycling ability contained questions about the favorite transport means, the importance of cycling for the patient and for what purposes he uses the bicycle. Each patient was asked to make a top 5 of the most important means of transportation, including car, bicycle, walking, public transportation and scooter/motorcycle. The first and second most important means of transportation were considered as the most important for the patient. The importance of cycling to a patient was scored with a 5-item Likert scale (very important, important, neutral, unimportant, totally unimportant). Additionally, the limitations in daily living and the degree of the limitations were questioned, including how well a patient could cycle now and whether he experienced pain while riding a bike.

The response rate was defined as the number of patients that answered divided by the total number of patients who received a questionnaire. A response rate of 60\% was considered as representative for the population.

The results of this survey were analyzed to evaluate the important predictors of cycling for knee patients. Sub-analyses were performed for patients with meniscal and or ligamentous injuries, osteoarthritis and patients with a Total Knee Arthroplasty. To evaluate the importance of pain during cycling and the limitation in cycling (on a 5-item Likert scale), Spearman correlation coefficients between these questions and the bodily pain and physical functioning domain of the SF-36 were calculated. A logistic regression analysis was performed with backward selection procedure to determine the predictive factors for pain experience and ability to cycle. First, univariate tests were performed to assess differences between the factors such as diagnosis, sex, age, BMI, ethnic background and level of education. Second, those covariate factors that were significantly related to pain experience or the ability to cycle in the univariate analysis were entered in a logistic regression model to determine whether the risk of experiencing pain or being able to cycle was related to these factors. Odds Ratio's and accompanying 95\% confidence intervals (CI) were determined. A \( p \)-value <0.05 was considered as statistically significant.
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Results

Two hundred eighty-five out of 400 patients returned the set of questionnaires. After calling the non-responders, another 13 sets of questionnaires returned. In total, 298 patients returned the questionnaire resulting in a response rate of 75%.

From the included 298 patients, 93 patients had osteoarthritis of the knee, 118 received a primary TKA and 87 had a meniscal and/or ligamentous injury. The average follow-up of TKA patients was 3.1 years (SD 2.0). The demographics of these patients are shown in table 1.

Table 1. Demographics of the study population. *ANOVA – test resulted in statistically significant differences between all the groups separately. # Chi-square-test.

<table>
<thead>
<tr>
<th>Group</th>
<th>Osteoarthritis</th>
<th>TKA</th>
<th>Meniscal or ligamentous injury</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean, range)</td>
<td>60.4 (27.5-85.7)</td>
<td>71.9 (36.4-90.0)</td>
<td>42.3 (14.7-75.0)</td>
<td>(p&lt;0.001)*</td>
</tr>
<tr>
<td>Male/female</td>
<td>41/52</td>
<td>43/75</td>
<td>36/51</td>
<td>N.S.#</td>
</tr>
<tr>
<td>Race (% caucasian)</td>
<td>83 (89%)</td>
<td>107 (91%)</td>
<td>77 (86%)</td>
<td>N.S.#</td>
</tr>
</tbody>
</table>

The most important means of transport was the car for 195 patients (65%), walking for 177 patients (59%) and cycling for 132 patients (44%) (Table 2). The importance of cycling was scored by 153 patients (51%) as very important to important.

From the 298 patients who completed the questionnaire, 194 (65%) did use their bicycle, 75 (25%) did not cycle and of these 75 patients 29 (10%) were not able to cycle. From the 259 patients who responded to the question, 124 (48%) used their bicycle on a regular basis for activities of daily living (ADL) including transportation to work and doing grocery shopping (table 2).

Table 2 Importance of cycling in the three knee groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Osteoarthritis</th>
<th>TKA</th>
<th>Meniscal or ligamentous injury</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent cycler</td>
<td>60/93 (65%)</td>
<td>64/118 (54%)</td>
<td>70/87 (81%)</td>
<td>(p=0.001)</td>
</tr>
<tr>
<td>cycle as important transportation</td>
<td>44/92 (48%)</td>
<td>42/118 (36%)</td>
<td>46/87 (53%)</td>
<td>(p=0.04)</td>
</tr>
<tr>
<td>Car as important Transportation</td>
<td>61/93 (66%)</td>
<td>72/118 (61%)</td>
<td>62/87 (71%)</td>
<td>N.S.</td>
</tr>
<tr>
<td>cycle for ADL</td>
<td>39/87 (45%)</td>
<td>41/87 (47%)</td>
<td>44/85 (52%)</td>
<td>N.S.</td>
</tr>
</tbody>
</table>
Predictors of cycle use in three groups of knee patients

Table 3 Pain and limitations with cycling in the three knee groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Osteoarthritis</th>
<th>TKA</th>
<th>Meniscal or ligamentous Injury</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain during cycling (n=227)</td>
<td>30/69 (44%)</td>
<td>34/85 (40%)</td>
<td>24/73 (33%)</td>
<td>N.S.</td>
</tr>
<tr>
<td>Limited in cycling (n=192)</td>
<td>34/59 (58%)</td>
<td>57/87 (66%)</td>
<td>27/46 (59%)</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

The questions regarding limitations experienced during cycling because of their current knee problem was particularly seen with TKA patients. Here 57 patients (66%) mentioned that they felt limited in their ability to ride a bicycle (Table 3).

No strong correlations were present between the relevant domains of the SF-36 and pain during cycling and limitation in cycling. SF-36 bodily pain against pain during cycling resulted in $r=0.37$ ($p<0.001$) and the IKDC versus pain during cycling resulted in $r=0.52$ ($p=0<0.001$), which is a poor correlation. Limitation in cycling ability versus SF-36 physical functioning resulted also in a correlation of $r=0.28$ ($p<0.001$) and versus the IKDC in a $r=0.36$ ($p<0.001$).

Univariate analysis showed diagnosis, BMI, age and sex as significant predictors for ability to cycle at follow up. These factors were entered in a multivariate backward analysis for this outcome. These Multivariate analysis for ability to cycle showed that age OR 0.95 (95%CI: 0.93-0.98) and sex OR 1.98 (95%CI: 1.14-3.42) were the only significant factors remaining in the model. This means that in the study population the chance to be able to cycle for male patients is 1.98 times as high compared to female patients, and that each year that the patient gets older, the chance to be able to cycle, will decrease by 5%.

Univariate analysis showed diagnosis, age and BMI as significant predictors for pain while cycling at follow up. These factors are entered in a multivariate backward analysis for this outcome. This Multivariate analysis for pain whilst cycling showed only BMI remained as a significant factor in this multivariate model with an OR of 1.08 (1.03-1.14). This means that with each BMI increase of one unit, the chance to experience knee pain while cycling will increase by 8%.
Discussion

Various studies support sports recommendations for knee patients and have shown the importance of regular exercise, some of them even report the effectiveness of cycling \cite{5,10,13,7,12}. Cycling is a popular international professional and recreational sport performed by both sexes and all age groups \cite{3,6,10,13,12,2}. From the literature and our own clinical experience it is known that being able to cycle is important for many knee patients \cite{3,5-6,13,7,2}. It is estimated that 49 million US citizens cycle at least once a month and over 5 million more than 20 days a month \cite{2}. The bicycle is not only used for sporting activities but also for recreational activities and as a means of transportation. The CPB Netherlands Bureau for Economic Policy Analysis shows that, second to the car, the bicycle is an important mean of personal transportation \cite{3}. As far as we know, no other study has been published assessing the predictors of cycling use in knee patients.

The majority of the patients in this study were able to cycle at the time they visited the outpatient clinic. Based on the fact that 65% of all these patients frequently use a bicycle for transport and that 48% are dependent of their bicycle for activities of daily living it seems that cycling is important for this population.

Kuster and Ericson emphasize that cycling compared to walking gives lower tibio-femoral compressive forces while improving general health and therefore decreasing polyethylene wear in total knee arthroplasty \cite{7,12}. Studies performed by Ericson and later D’Lima showed that the mean tibio-femoral compressive force is 1-1.2 times body weight (BW) with ergometric cycling and this compared to normal walking with 2.8-3.5 times BW \cite{4,7}. The tibio-femoral compressive force can further be decreased by increasing the saddle height \cite{7}.

There is a poor correlation between pain during cycling, bodily pain scored with the SF-36 and the ability and possible limitations during cycling.

As in other subjective knee related outcome scores, questions regarding walking, running and even sports are incorporated. However, no questions inform about ability to cycle. The poor correlations could both be caused by the unimportance of cycling or the design of these questionnaires \cite{6,8}. Another contributing factor could be that patients seem to adapt their lifestyle when experiencing pain, a limited range of motion or anxiety to fall. Patients therefore rather take the car or use public transport. If patients are afraid of falling, the
advice may be to use a home trainer to improve cardio-pulmonary health and muscle strength.

A possible limitation of the study is that not all patients responded to our request. Efforts were made to reduce the number of non-responders by contacting them by telephone, finally resulting in a response rate of 75%, which is considered to be sufficient. A low response rate increases the possibility that the responders are not a representative sample and therefore increase the risk of a non-respondent bias.

In the study population, the ability to cycle is mainly predicted by age and sex and not by the specific knee-related diagnosis. Each year that the patient gets older, the chances of being able to cycle will decrease by 5%. The chance to be able to cycle is 1.98 times higher for male patients compared to female patients. Most studies agree on this, but Naal et al. saw no difference between sex and even that their older patients were more active. A possible explanation could be that their group of hemiarthroplasty patients are more active than the average group of total knee arthroplasty patients. BMI is the only risk factor found for pain experience during cycling. This means that with each BMI increase of one unit, the chance of experiencing knee pain while cycling will increase by 8%. A study performed by Dahm et al. concluded that age (<70 years), being male and having a BMI less or equal to 30 kg/m² are correlated to a higher activity level. We found it predictable that younger patients are more able to cycle than older, but we have difficulty explaining why men are more able to cycle than women. Current literature does not give us an explanation and we can only speculate that muscle strength or hormonal influences may play a role in this.

**Conclusion**

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.
References