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Subjective Functional Knee Outcomes following Anterior Cruciate Ligament Reconstructive Surgery

Malissa K. Hauser
University of North Dakota

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SUBJECTIVE FUNCTIONAL KNEE OUTCOMES FOLLOWING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTIVE SURGERY

by

Malissa K. Hauser
Bachelor of Science in Physical Therapy
University of North Dakota, 1993

An Independent Study
Submitted to the Graduate Faculty of the
Department of Physical Therapy
School of Medicine
University of North Dakota
in partial fulfillment of the requirements
for the degree of
Master in Physical Therapy

Grand Forks, North Dakota
May
1994
This Independent Study Report, submitted by Malissa Hauser in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(Faculty Preceptor)

(Graduate School Advisor)

(Chairperson, Physical Therapy)
PERMISSION

Title Subjective Functional Knee Outcomes Following Anterior Cruciate Ligament Reconstructive Surgery

Department Physical Therapy

Degree Master of Physical Therapy

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Signature Malissa Hanser

Date 2/28/94
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ABSTRACT

It is established in the literature that primary repair of the anterior cruciate ligament (ACL) deficient knee is achieved through means of reconstructive surgery. However, with continuing advances in both the surgical technique performed and, consequently, the rehabilitation program implemented following reconstruction, the need for ongoing research becomes essential in evaluating the long-term effectiveness of such changes. Currently, the long-term follow-up studies available on ACL reconstructive surgery report information through means of clinical evaluation and objective testing measures with little or no emphasis on the value of the patient’s subjective responses. The purpose of this study is to determine the subjective functional knee outcomes obtained from a group of patients following ACL reconstruction and to demonstrate that subjective information is an essential component in predicting patient satisfaction and overall functional level. The methodology entailed contact of 325 patients who underwent bone-patellar tendon-bone autograft reconstructive surgery by mail through the use of a questionnaire form. A total of 90 subjects (n=90, 46 males and 44 females) with ages ranging from 18 to 52 years (X=28.79) were used in the data collection and statistical analysis. The results indicated that the three most predictive factors of the overall
functional knee outcome reported subjectively by the patient include stability of the knee, stair climbing, and the occurrence of swelling. A postoperative data summary of the patients' activity level following surgery revealed that there was a 47% return to a preinjury activity level or better. Significant variable associations were also found between the ability to predict the functional outcome of the knee and the type of surgical procedures performed. Further analysis of the subjective information obtained in this study suggests that subjective questioning of the patient is a valuable component which can be used in predicting patient satisfaction and the overall functional level of the knee following ACL reconstructive surgery.
CHAPTER I
INTRODUCTION

Anterior cruciate ligament (ACL) injuries are one of the more prevalent causes of knee problems encountered today. Although it is a strong ligament, the ACL is the most frequently torn ligament in the knee.\textsuperscript{1} Previous emphasis on conservative management of an acutely ruptured ACL is now almost obsolete for use in the active or athletic individual. Results from numerous longitudinal studies have indicated that the conservative, nonsurgical approach to treatment of ACL deficiencies can lead to progressive rotatory instability, meniscal damage, and early degeneration changes within the knee joint.\textsuperscript{2-8}

In recent years, considerable changes have been made in the treatment of ACL deficiencies in both the surgical technique performed and, consequently, the type of rehabilitation program implemented following reconstruction. The switch to a less invasive surgical procedure and a more aggressive rehabilitation has significantly increased the rate of recovery and return to functional activities, thus indicating the need for ongoing research in this area to evaluate the long-term effectiveness of such changes. In 1991, Sommerlath et al\textsuperscript{6} stated that the frequent change in the treatment of ACL injuries seems to
imply that a satisfactory solution has not been found and that there is inadequate knowledge about the long-term effects of the available techniques.

The first documented repair of the ACL was recorded by Robson in 1903. Since that time, many techniques have been developed and refined for use in repairing and replacing this ligament. In conjunction with the variety of techniques attempted, surgeons have also experimented with numerous substitutes for the ruptured ACL. Tissues that have been suggested for use as substitutes include various autogenic tissues, allogenic tissues, and synthetic materials. However, current literature indicates that use of the patellar tendon autograft is the most effective replacement for the ACL due to its similar characteristics, initial strength, tendon-bone interface, and associated bone blocks which allow healing and rigid fixation. Autogenic grafts are also preferred over allogenic grafts due to the increased risk of infections following surgery and the limited research on the use of allografts.

Campbell was one of the first to describe the use of the middle one-third of the patellar tendon as a substitute for the ACL. In 1963, Jones described a technique using the central portion of the patellar tendon leaving the distal portion attached to the tibia. Due to the orientation of the graft from its distal attachment, it was neither anatomically nor isometrically placed correctly to reproduce the characteristics of the original ACL. Therefore, most resulted in failure of the graft or in joint motion restriction following the surgery. In addition, Maclntoch and Marshall introduced use of the lateral one-third of the patellar
tendon in combination with a portion of the aponeurotic tissue take from the anterior patellar surface. Problems associated with this technique involved weakness in the graft as it transversed across the joint resulting in inadequate strength when used as a substitute. The need to correct such problems associated with these early reparative techniques in turn lead to the development of an advanced reconstructive procedure.

In 1982, Clancy advocated the use of a modified Jones technique using a free graft from the central one-third of the patellar tendon. The only disadvantage reported from this procedure was the disruption of the extensor musculature in the knee. In 1983, CaBaud also addressed the importance of proper graft position, tension, alignment, and preservation of the graft’s blood supply. Recently, advances have been made in the accuracy of this technique due to the advent of the arthroscope in assisting ACL reconstruction. Utilization of the arthroscopically "assisted" ACL reconstruction technique provides advantages to both the surgeon and the patient by allowing excellent illumination and magnification within the joint, more precise placement of the graft, minimized soft tissue disruption, reduced postoperative pain and scarring, lessening both the morbidity and rehabilitation time following surgery.

Most authors agree that primary repair of the ACL is necessary in order to maintain overall knee function in the active individual. However, controversy exists as to what type of rehabilitation protocol should be implemented following ACL reconstruction. The shift to a more aggressive
rehabilitation program was introduced in 1986 after observations of the successful outcomes obtained in noncompliant patients far outmeasured those obtained from patients who were compliant. The patients who demonstrated noncompliance in the conservative rehabilitation protocol progressed as desired without regard to the established guidelines, however, obtained earlier terminal extension without compromising the stability of the knee.\textsuperscript{20,23-24} Based on this research and the continued follow-up of the noncompliant patients, it was determined that a more aggressive rehabilitation program could be safely implemented without deleterious effects on the new graft. The advantages that the accelerated rehabilitation program offered over the traditional, more conservative approach, included increased patient compliance and cooperation, earlier return to functional activities, decreased incidence of patellofemoral problems, and earlier return of terminal knee extension.\textsuperscript{10,23}

There is a vast amount of literature available in the area of ACL reconstruction. Unfortunately, results from many of the follow-up studies present with discrepancy as to what the long-term effects are following surgery.\textsuperscript{13,25} These inconsistencies may be partly due to the fact that, in the literature, there are a number of surgical procedures performed and variations in the rehabilitation programs implemented following the surgery. Since the introduction of the accelerated program, many facilities have developed versions of the original accelerated rehabilitation protocol. Unfortunately, the majority of the research behind the development of these protocols is based on
a specific surgical technique and is often applied to numerous patients who have undergone alterations in the surgical procedure.\textsuperscript{12} The development of a rehabilitation program based on the biomechanical properties of the graft and its placement is likely to result in success.\textsuperscript{12,18,25}

Currently in the literature, there are numerous long-term studies regarding the follow-up of ACL reconstructive surgery.\textsuperscript{3,6,19,23} Many of these studies report outcomes through means of clinical evaluation techniques and objective testing measures with little or no information accounting for the patient’s view of his/her postoperative functioning. However, in a recent study conducted by Draper and Ladd,\textsuperscript{26} 180 patients who had undergone a bone-patellar tendon-bone autograft reconstruction were surveyed to determine their functional abilities and activity levels. The survey consisted of questions regarding preinjury and postinjury activity levels, pain and stability, and the Lysholm knee rating scale. The patients included in this study were all functioning within the range of one or two years postoperatively. Results from the study indicate that, although objective information is extremely valuable in determining the postoperative outcomes of the knee, the patient’s subjective perception of functioning is an important factor in determining successful return to a preinjury activity level and should be included routinely as part of the assessment.

Proprioception is another important factor in predicting patient satisfaction and surgery success. In 1991, Barrett\textsuperscript{2} conducted a study to
identify the factors that were most important in determining success following ACL reconstruction. The results of the study indicated that the accuracy of proprioception in the knee following surgery correlated well with both the patient's satisfaction ($r=0.9$) and with the functional outcome ($r=0.81$). However, a poor correlation was found between the Lysholm knee rating scores and the patient's satisfaction ($r=-0.18$), between the Lysholm scores and the functional outcome ($r=0.24$), and between clinical ligament testing and both the patient's subjective assessment ($r=0.18$) and the functional outcome ($r=0.19$). The author's findings lead to the conclusion that the success of the surgery may not depend directly on the tightness or strength of the graft, but rather on the amount of proprioception available in the knee following reconstruction. Other authors have also noted that there may be a poor correlation between both the objective evaluation measures and knee rating scales to that of the patient's satisfaction and ability to return to activities following ACL reconstruction.\textsuperscript{5,17,27}

It is established in the literature that the primary treatment of the ACL deficient knee is achieved through means of reconstructive surgery, yet there is dispute as to what the appropriate treatment entails. Variations in both the surgical procedures and the type of rehabilitation program implemented following reconstruction leaves discrepancies in the research and lacks consistency in the findings on any particular technique or protocol. In addition, the majority of the research available on the follow-up of patients who have
undergone surgery is presented in terms of objective information with little or no emphasis on the patient's subjective responses. The purpose of this study is to determine the subjective functional knee outcomes obtained from a group of patients following ACL reconstruction and to demonstrate that subjective information is an essential component in predicting patient satisfaction and overall functional level. It is hypothesized that by including the patient as a significant participant in the follow-up study, valuable subjective information will be obtained which can be used as a good indication of the overall functional level postoperatively. It is also anticipated the results from this study may be used to stimulate further research in this area and to provide an increased awareness of the value of subjective information.
CHAPTER II
LITERATURE REVIEW

The clinician's ability to accurately evaluate a patient's functional outcome following knee surgery continues to present a challenge. Objective testing measures have been shown to be reliable and are commonly used within the clinical setting throughout the phases of rehabilitation. In addition, subjective information is also an essential part of the evaluation, becoming even more applicable in long-term follow-up studies. Tegner and Lysholm\textsuperscript{27} noted the need for a comprehensive assessment, including both subjective and objective information, but reported that the importance of each particular part of the evaluation can vary throughout the course of treatment and the follow-up period. Therefore, the clinician must be aware of the patient's subjective complaints and know when and how to incorporate them into the treatment program and goal setting plan.

As early as 1955, O'Donoghue\textsuperscript{28} raised the need for analysis of subjective information in the treatment and follow-up of knee problems. Unfortunately, the use of subjective information is somewhat limited in that it often becomes secondary to the more easily measured and recorded objective results. Because subjective data are often difficult to measure, they cannot be
easily quantified, thereby making analysis complicated and the reliability of its use somewhat questionable. The idea behind the development of knee rating forms or scoring scales is that by making subjective data more quantifiable or objective in terms of measuring, clinicians can increase the power of using such information in their assessment.\textsuperscript{29,30}

In the past few decades, the development and use of many types of quantifiable subjective scoring scales have gained increased popularity. It can be seen in the literature that many of the available knee scales are similar in content and are often no more than variations or modifications of earlier scoring systems used to evaluate subjective information.\textsuperscript{27,30-34} Often, much of the information obtained from the knee scoring scales includes questions regarding the patient's postoperative symptoms, patient compliance, and the return to functional or sporting activities.

Research on the content of the questions included in the knee scoring scales is somewhat limited in the literature. Earlier documented research is available on the construction of some of the more popular knee scoring scales.\textsuperscript{27-34} However, the need for a comprehensive knee evaluation form which considers individualized activity levels, subjective complaints, and functional outcomes are essential when developing a subjective evaluation form. The discussion which follows supports the inclusion of specific subjective questioning used in the construction of the questionnaire presented in this study.
In 1982, Lysholm and Gillquist designed a scoring scale used to evaluate subjective information from patients following reconstructive surgery with emphasis on questions regarding symptoms of instability. Four groups of patients with knee related problems participated in the study. Scores obtained from this scale were compared to the scores obtained from the modified Larson scale which did not include questions on instability. Findings from this study indicated that there was a correlation between the total score on their scale and the patient's own opinion of function. A correlation was also reported between the feelings of instability and the failure to return to a preinjury activity level. Thus, introducing the need to include questions regarding knee stability in the patient's subjective evaluation, as was also pointed out by Marshall and associates.

In 1991, a study by Flandry et al analyzed subjective knee complaints from patients who had either undergone knee surgery or who were diagnosed with a knee disorder by using a visual analog scale (VAS). The goal in developing a VAS was to allow the examiner to objectively record the patient's subjective responses in an accurate, efficient, and easily communicable manner. In this study, the validity of the VAS was compared to three other knee rating scales. The results of the study demonstrated that the use of the VAS allowed a patient's subjective response to be converted into a specific objective magnitude easily and quickly. The validity, increased sensitivity, increased patient compliance, and decreased examiner bias were documented.
in the study, thereby supporting inclusion of such types of questions in the patient's subjective assessment. Huskisson also noted that the use of the VAS in measuring pain appeared to produce the most sensitive results.\textsuperscript{35}

Another important factor in determining the success of the reconstructive procedure in many individuals is the ability to return to functional or sport activities. The main advantage of including a preinjury activity level and a postsurgical activity level is not to compare different patients, but instead to compare the change in activity levels in the same person following repair.\textsuperscript{27,34} In addition to including questions on post-surgical activity levels, it is also important to include an overall view of the outcome of the surgery. It has been documented that the use of categories such as excellent, good, fair, and poor correlate well with the patient's own evaluations of the condition of the knee and the physicians' objective physical assessment.\textsuperscript{33}

As a clinician, the most effective and comprehensive means of evaluating a patient following ACL reconstructive surgery is to include both objective and subjective material routinely in the assessment. More importantly, it is essential to individualize the evaluation in accordance with each patient's interests and desired activity or functional level following surgery. Due to the changes in both the surgical techniques performed and, consequently, the type of rehabilitation program implemented following reconstruction, the need for continued long-term follow-up studies is crucial. The purpose of this study is to determine the subjective functional knee outcomes obtained from a group of
patients following reconstructive surgery and to demonstrate that subjective information is an essential component in predicting patient satisfaction and overall functional level.
CHAPTER III

METHODS

Subjects

Three hundred twenty-five patients who underwent bone-patellar tendon-bone autograft reconstructive surgery at a local Midwest hospital within the period from September 1987 to September 1992 were contacted by mail through the use of a questionnaire. Of the 325 surveys sent out, 35 did not reach the intended persons due to incorrect or expired forwarding addresses and were returned to sender. Ninety-eight patients returned the questionnaire resulting in a response rate of 33.79%. Of the 98 respondents, eight were eliminated due to extensive surgical reparative procedures or due to the age of the patient resulting in data collection obtained from a sample total of 90 subjects (n=90, 46 males and 44 females). The mean age of the subjects was 28.79 (Range=18 to 52, SD=9.00).

The criteria for inclusion in the study was made on the basis that the subjects were at least 18 years of age at the time of the questionnaire mailing and one year or more postoperative. To control for surgical variation, the subject pool was limited to those seen by one specific orthopedic surgeon within a specified time frame to assure a similar reconstructive procedure was
used. In addition, the rehabilitation protocol implemented remained consistent over the specified time frame. The only significant change in the protocol noted was earlier weight bearing in the patients who underwent surgery within approximately the past three years.36

Procedure

Methodology entailed access to the addresses of those patients who underwent ACL reconstructive surgery at a local Midwest hospital within the time period from September 1988 to September 1992. Selection of the entire population was based on the time and financial constraints of the researcher. The addresses were obtained through the medical records department after approval of this study by the University of North Dakota Institutional Review Board and the Medical Park Institutional Review Committee (Appendix A).

The 26-item questionnaire form used in this study consisted of questions regarding the patient’s knee pain, swelling, stability, compliance, functional activities, and a rating of the overall condition of the knee following surgery. The types of questions contained in the survey included visual analog scales, multiple choice questions, open-ended questions, and binary questions requiring simple yes/no responses. The questionnaire was designed to be relatively simple and easy to complete in hopes of increasing the subject response rate while still obtaining the necessary subjective information from the patient. A cover letter included in the mailing of the questionnaire explained the purpose of the study and the subject’s right to confidentiality (Appendix B).
The subjects who responded to the questionnaire within a period of six weeks were used in this study for data collection. The type of surgical procedure or procedures performed on the respondents were obtained through a medical record chart review. Those subjects who underwent extensive surgical reparative procedures were eliminated from the data base. All information was collected in a codified form to ensure patient confidentiality.

Analysis

The data were classified as either nominal, ordinal, or interval/ratio. All ordinal variables were assigned a numerical value with the lower values corresponding to the higher ranking variables. There were three questions involving interval/ratio variables which were given numerical values ranging from 0 to 10 on a visual analog scale. The Pearson Correlation Coefficient test was used to analyze the significant correlation between the surgery date and the patient's subjective rating of the overall condition of the knee, between the difference in the preinjury activity level scores minus the postinjury activity level scores and the overall condition of the knee, between the occurrence of reinjury and overall condition of the knee, and between the patient's choice to have reconstructive surgery again and the overall condition of the knee. A Wilcoxon Matched-Pairs Signed-Ranks test was used to determine if there was a significant difference in the patient's change in activity level obtained before injury and following surgery. A Multiple Regression test was used to analyze significant variable association with regard to the extent of injury and also to
analyze the patient's subjective rating of the overall condition of the knee following surgery to determine those variables which best predict functional knee outcomes. All variables were accepted as significant at the 0.05 level.
CHAPTER IV

RESULTS

A total of 90 subjects were used in the data collection for this study. Percentages were tabulated for the subject's responses to each question (Appendix C). In addition, pertinent functional data were obtained. When asked to describe the knee pain, only 10.1% reported that they had no pain in the knee, while 3.4% of the patients had complained of constant pain. Quantifying the worst pain felt in the knee, 44.4% rated the pain at a level 5 or greater on a visual analog scale ranging from 0 (no pain) to 10 (severe pain, even at rest). The occurrence of swelling to a certain degree was present in 55.1%. The subjective perception of knee stability was variable with 54.4% described no periods of giving away, while 23.3% reported knee instability ranging from an occasional to constant occurrence of giving way with daily activity. During stair climbing, 22.2% of the patients reported some difficulty. The compliance with an exercise program for one year or more was reported at 47.2%, while 84.5% reported no change in the work activity following surgery. The overall functional knee outcomes rated at the time of the questionnaire mailing were reported as being excellent in 25.6%, good in 58.9%, fair in
10.0%, and poor in 5.6% of the subjects. The most common activities which cause knee pain in those who responded are reported in Figure 1.

A Wilcoxon Matched-Pairs Signed-Ranks test was used to compare the level of sports activity before injury to the level of sports activity following surgery. Of the 90 subjects who participated in this study, nine were eliminated due to incomplete or inappropriate responses to this question resulting in a total of 81 subject responses (n=81). Results were significant (p<0.001, two-tailed test) indicating that the patient's subjective rating of activity level significantly decreased following surgery. Six (7%) were participating at a higher activity level than prior to injury, 32 (40%) had returned to their preinjury activity level, while 43 (53%) reduced their activity level following surgery. The postoperative data summary indicated that there was a 47% return to a preinjury activity level or better in this study. The data collected regarding the difference in activity level before and after surgery are represented as percentages in Figure 2.

The following results were obtained using the Pearson Correlation Coefficient test. No significant difference (p=.407) was found between the date of surgery and the patient's subjective rating of the overall condition of the knee. No significant difference (p=.208) was found between the difference in the ranks of scores in activity level before minus the activity level after surgery as compared to the overall condition of the knee. However, a significant, negative correlation (p=.031, r=-.2271) was found between the overall condition of the knee and the occurrence of further injury. As the number of injuries
increased after ACL reconstructive surgery, the patient's subjective rating of the overall condition of the knee decreased. As indicated by the subjects' responses, a total of 15.6% described an incident of further injury to the knee. A significant, positive correlation \( (p=.001, r=.3599) \) was also found between the overall condition of the knee and the patient's reconsideration to go through the surgery again. Those patients who rated the overall condition of their knee as being high would still choose to have reconstructive knee surgery if they could make the choice again. According to the responses, 89.9% of the patients reported that they would choose to have reconstructive surgery again. The subjective comments to the questionnaire are complied in Appendix D.

The percentages of the type of surgical procedures performed on those who responded to the questionnaire can be seen in Figure 3. In addition to the data presented in this figure, a variety of combinations of the surgical procedures were performed with the most commonly performed procedure being repair of the ACL with a partial lateral meniscectomy recorded at 23.3%. Of further interest is the documented 11.1% of isolated ACL reconstruction in this sample.

A Multiple Regression analysis was conducted to determine the ability to predict the patient's subjective functional knee outcome depending on the type of surgical procedure performed in addition to the primary replacement of the anterior cruciate ligament. Significant results \( (p<0.05) \) can be seen in Table 1. The complete Multiple Regression analysis table is included in Appendix E.
Surgery 1 - Partial Medial Menisectomy
Surgery 2 - Partial Lateral Menisectomy
Surgery 3 - Medial Meniscus Repair
Surgery 4 - Lateral Meniscus Repair
Surgery 5 - P-L Augmentation
Surgery 6 - MCL Repair

PERCENT

<table>
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<th>Surgery Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<tr>
<td></td>
<td>39.5</td>
<td>55.8</td>
<td>5.8</td>
<td>2.3</td>
<td>18.6</td>
<td>11.6</td>
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Table 1. Variables Associated with the Type of Surgical Procedure

<table>
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<tr>
<th>VARIABLE</th>
<th>Beta</th>
<th>Sign Level</th>
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<tr>
<td>MCL Repair + Pain Intensity</td>
<td>-.266</td>
<td>.0180</td>
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<tr>
<td>MCL Repair + Description of Pain</td>
<td>-.236</td>
<td>.0359</td>
</tr>
<tr>
<td>MCL Repair + Description of Knee Stab</td>
<td>-.232</td>
<td>.0425</td>
</tr>
<tr>
<td>MCL Repair + Overall Knee Condition-</td>
<td>.228</td>
<td>.0440</td>
</tr>
<tr>
<td>Partial Lat Meniscectomy+ Knee Movement</td>
<td>.239</td>
<td>.0356</td>
</tr>
<tr>
<td>P-L Augmentation + Knee Movement</td>
<td>-.223</td>
<td>.0412</td>
</tr>
<tr>
<td>Medial Meniscus Repair + Compliance</td>
<td>.378</td>
<td>.0014</td>
</tr>
</tbody>
</table>

A Multiple Regression analysis was also used to examine the patient's subjective rating of the overall condition of the knee following surgery to determine those variables which best predict functional outcomes can be seen in Table 2.

Table 2. Variables Predictive of Subjective Functional Knee Outcomes

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>BETA</th>
<th>SIGN LEVEL</th>
<th>RSQ</th>
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<tbody>
<tr>
<td>Description of Stability</td>
<td>0.325</td>
<td>0.0013</td>
<td>0.2746</td>
</tr>
<tr>
<td>Ability to Stair Climb</td>
<td>0.299</td>
<td>0.0028</td>
<td>0.3911</td>
</tr>
<tr>
<td>Occurrence of Swelling</td>
<td>0.262</td>
<td>0.0091</td>
<td>0.4465</td>
</tr>
</tbody>
</table>

The subject's description of the amount of stability accounted for 27.46% of the variability of the factors associated with the reported subjective functional outcome. Stability and problems encountered during stair climbing together accounted for 39.11% of the variability, while stability, stair climbing, and the occurrence of swelling in the knee accounted for 44.64% of the variability. The
results indicate that in this study these variables are the best predictors of the overall condition of the knee when rated subjectively by the patient.
CHAPTER V
DISCUSSION

The patients' unique perception of the functional outcome of their knee following ACL reconstruction is one that cannot be obtained from anyone other than the patients themselves. Even though clinical evaluation techniques and objective testing measures are shown to be accurate and reliable, the patient is ultimately the one who reports the satisfaction as to the outcome of the surgery. This becomes even more important when determining the long-term effectiveness of ACL reconstructive surgery where objective information is often more difficult to obtain. The intent of this study was to construct a questionnaire which could be used solely as a subjective follow-up for a group of patients who underwent ACL reconstructive surgery. This study was particularly informative for me personally, in addition to professionally, in that I have also undergone ACL reconstructive surgery and felt that many questions regarding the long-term results and functional outcomes were often unanswered and inconsistent. In an attempt to demonstrate that value and relevance of subjective information, a discussion of the results found in this study will follow.

The results found in this study demonstrated that the patient's subjective description of the stability within the knee was found to be most predictive of
the patient's overall functional outcome rating. Similar results have been
reported in the literature. In a study conducted by Barrett,\textsuperscript{2} the author
concluded that the amount of proprioception in the knee correlated well with
both the functional outcome and the patient's satisfaction following ACL
reconstructive surgery, while others have shown that knee instability is
associated with a decreased return to a preinjury activity level.\textsuperscript{6,19,31,33} These
two factors may negatively affect how the patient views the overall outcome of
the surgery. Furthermore, decreased proprioception and the feeling of
instability may be essentially the factor which prevents a patient with a clinically
stable knee from returning to a preinjury activity level, as was also pointed out
by Barrett.\textsuperscript{2} Other factors such as decreased confidence and the fear of further
injury to the reconstructed knee may be involved as well and was relayed by
the subjective comments provided by a number of the respondents.

In addition to the feeling of instability, problems associated with stair
climbing and the patient's subjective description of the frequency of swelling
were found to be the variables next most predictive of the patient's overall
functional outcome, respectively. These three independent variables collectively
accounted for 44.64\% of the variability of the factors associated with the
reported functional outcome and, therefore, were found to be the best
predictors of the overall knee function when rated subjectively by the patient.

According to this study, this is of clinical importance in that questions regarding
knee stability, stair climbing, and the incidence of swelling should be included routinely in the subjective assessment.

The ability to resume a preinjury activity level has also been shown to be an important factor in determining a successful outcome following ACL reconstructive surgery.27 Currently, the range of reported return to a preinjury activity level varies from 18% to 77% in the literature with variable reconstructive procedures and rehabilitation protocols implemented, in addition to follow-up periods which ranged from 5 to 16 years postoperatively.3,19,26 As noted in this study, the patient's subjective rating of activity level was significantly lower following ACL reconstruction. Of the patients who responded, only 47% of the patients reported a return to a preinjury activity level or better following ACL reconstructive surgery. The reported percentage of return to activity found in this study fell almost exactly in between those previously recorded. Unfortunately, direct comparisons of the previously documented percentages of the return to preinjury activity levels are difficult, if not impossible, due to the variability noted within such studies. Further review of the subjective comments provided by the respondents in this study is most helpful in determining the reason for the decrease in activity. It is of importance to note that many of the subjects provided comments regarding their change in activity level following surgery in addition to expressing very strong views, both positively and negatively, on their functional outcomes.
Furthermore, analysis of the patient’s actual difference between the preinjury activity level minus the postsurgical activity level and the patient’s subjective rating of the overall condition of the knee revealed no significant relationship. Even though only 47% of the patients reported a return to a preinjury activity level or better, it appears that the change in activity level following surgery does not significantly affect the reported overall condition of the knee. One factor which may largely account for these findings is the patient’s personal choice to decrease his/her activity level following surgery. Self-limiting factors such as this may explain why the change in activity level following surgery did not significantly affect the reported outcome of the surgery. Therefore, it would appear that if the decrease in activity is seen as self-limiting, the reported functional outcome would tend to be higher than if the decrease in activity was seen as physically limiting. This was also conveyed by the comments provided on the questionnaire form.

When determining specific variable association as to the type of surgical procedures performed in addition to the primary reconstruction of the ACL, it was demonstrated that MCL repair was significantly related to the increased frequency and intensity of knee pain, the increased occurrence of knee instability, and the decreased rating of the overall functional outcome of the knee. Repair of the medial meniscus was related to an increased reported compliance with an exercise program. Partial lateral meniscectomy and posterior-lateral augmentation were both found to be factors related to the
patient's ability to move the knee. However, variable results were found between the two procedures. Patients significantly reported less locking and catching in the knee when a partial lateral meniscectomy was performed while patients undergoing posterior-lateral augmentation reported a significant increase in locking and/or catching of the knee.

In discussion of the findings of these surgical procedures, it appears that MCL repair performed in conjunction with ACL reconstruction tends to produce the most negative functional outcomes. Factors related to this may be due to the extensiveness of the reparative procedures performed, in addition to the subsequently compromised stability of the knee when two of the ligaments are injured. As documented in the literature objectively, collateral ligament involvement has been shown to adversely affect the outcome of ACL reconstructive surgery. Speculation as to relationship between the medial meniscus repair and the increased compliance may be due to the earlier placed restrictions on weight bearing and understanding the importance of compliance in the prevention of further meniscal damage as involvement of the meniscus is well documented to be a contributing factor in degenerative changes within the knee joint. The fact that the lateral meniscus has been shown to present with increased mobility within the knee joint may contribute to the significant decrease found in the subject's reported symptoms of catching and/or locking when a partial lateral meniscectomy was performed. Lastly, increased tension due to a posterior-lateral augmentation may account for a change the normal
alignment within the knee, thereby increasing the compressive forces and the incidence of catching and/or locking in the knee.

With continued discussion, reported results of the reliability of using subjective classifications for the overall knee functional outcome has been documented by Marshall et al\textsuperscript{33} in which categories such as excellent, good, fair and poor correlated well with the patient's own perception of the condition of the knee and the objective clinical assessment. This finding becomes particularly relevant when an entirely subjective follow-up study is conducted. In this study, analysis of much of the subjective information obtained from the patients was compared to the overall condition of the knee. A discussion of these findings will follow.

When comparing the date of surgery and the patient's subjective rating of the overall condition of the knee, no significant relationship was found. However, it is not surprising to find that as the occurrence of reinjury increased, the patient's subjective rating of the overall condition of the knee decreased. Although the overall functional outcome of the knee, within the time frame of one to five years postoperatively, does not significantly change over this period of time, further injury does cause the patient to rate the reconstructed knee as being significantly lower than if reinjury did not occur. Similar results have also been shown with the use of objective testing measures in which satisfactory results following ACL reconstruction do not deteriorate over a 10-year period.\textsuperscript{3}
Another factor related to the overall condition of the knee is the patient's reconsideration to have reconstructive surgery given present knee status. The results were significant indicating that those who rated their overall condition as being high appear to have no regrets as to having had reconstructive surgery, while those who rated the overall condition as being low may have opted to take a more conservative, nonsurgical approach if given the choice again. However, 89.9% responded positively in regard to having reconstructive surgery again, in addition to the supporting subjective comments in which many of the patients viewed the surgery and rehabilitation as a success.

In summary, it has been shown that patient satisfaction correlates well with the overall outcome demonstrating the importance of the patient's subjective assessment of the functioning of the knee. However, the problem is as Sommerlath et al stated, the frequent change in the treatment of the ACL deficient knee seems to imply that a satisfactory solution has not been found and that there is inadequate long-term knowledge regarding the effectiveness on any of the available techniques. Both the results and the variable subjective comments found in this study seem to support this statement.
CHAPTER VI
CONCLUSION

The continuing advances in both the surgical technique performed and, consequently, the rehabilitation program implemented following ACL reconstructive surgery warrant the need for ongoing research in this area to determine the long-term effectiveness of such changes. Unfortunately, long-term patient care and follow-up is limited as well as inconsistent in the current literature. The results of this study support the need for continued research and follow-up of patients who have underwent ACL reconstruction. As demonstrated, the results and comments obtained from the questionnaire seem to indicate the wide margin of variability in the satisfaction and functional knee outcomes reported following ACL reconstructive surgery.

As a clinician, the need to be aware of the importance and value of subjective information is essential and can therefore be a source of pertinent information as to the functional outcome of knee, in addition to monitoring the need for further improvements in the treatment following reconstructive surgery. As found in this study, the three most predictive factors of the subjective functional outcome of the knee include stability, stair climbing, and the occurrence of swelling, in order of importance respectively. Stability and the
proprioception within the knee joint, as was noted previously, are particularly important factors in predicting the successful outcome of the reconstructive surgery and, therefore, should be emphasized early in the rehabilitation program to enhance patient satisfaction and the reported functional knee outcomes.
APPENDIX A
PROJECT TITLE: Subjective Functional Knee Outcomes Following Anterior Cruciate Ligament Reconstructive Surgery

above referenced project was reviewed by a designated member for the University's Institutional Review Board on 9/2/93 and the following action was taken:

Project approved. EXPEITED REVIEW NO. 3.
Next scheduled review is on 9/2/94.

Project approved. EXEMPT CATEGORY NO. _____. No periodic review scheduled unless so stated in REMARKS SECTION.

Project approval pending receipt of corrections/additions in ORPD and approval by the IRB. This study may not be started until IRB approval has been received. (See REMARKS SECTION for further information.)

Project approval deferred. (See REMARKS SECTION for further information.)

Project denied. (See REMARKS SECTION for further information.)

REMARKS: Any changes in protocol or adverse occurrences in the course of the research project must be reported immediately to the IRB Chairman or ORPD.

Johnson, Adviser
San, Medical School

Signature of Chairperson or Designated IRB Member Date
UND's Institutional Review Board

the proposed project (clinical medical) is to be part of a research activity funded a Federal Agency, a special assurance statement or a completed 596 Form may be required. Contact ORPD to obtain the required documents. (7/93)
above referenced project was reviewed by the Medical Park Institutional Review Committee on September 2, 1993 and the following action was taken:

- Project approved. EXPEDITED REVIEW NO. ____________
  Next scheduled review is on ____________________________.
  (See REMARKS SECTION for any special condition.)

- Project approved. EXEMPT CATEGORY NO. ____________
  No periodic review scheduled unless so stated in REMARKS SECTION.

- Project approval deferred. (See REMARKS SECTION for further information.)

- Project denied. (See REMARKS SECTION for further information.)

ARKS:

Any changes in protocol or adverse occurrences in the course of the research project must be reported immediately to the IRC chairperson or IRC office (780-6161).

Signature of Chairperson or Designated IRC Member 9/8/93
Medical Park Institutional Review Committee

A proposed project is to be part of a research activity funded by a federal agency, a special assurance statement or a signed 596 Form may be required. Contact IRC office to obtain the required documents.
APPENDIX B
November 1, 1993

Survey Participants:

You are invited to participate in a research project conducted by Malissa Hauser, a graduate student in the physical therapy program at the University of North Dakota, who is working in conjunction with the Sports Medicine Department of the Grand Forks Clinic. The purpose of this study is to determine how you, the patient, view the outcome of your surgery. Enclosed is a questionnaire sent to a pool of selected patients who have undergone anterior cruciate ligament (ACL) reconstructive surgery of the knee. The information obtained from the questionnaire will allow us to look at the overall functional level of the knee and any long term effects or complaints patients may have following ACL reconstructive surgery from the one person who knows the best, namely YOU!

Included is a questionnaire form which can be completed and sent directly to the Bureau of Educational Services & Applied Research at the University of North Dakota. All information obtained from the questionnaire will be kept strictly confidential and will be used only for the intended purpose of this research project. Your name will not appear anywhere in the study. For research purposes, please respond as quickly as possible.

If you have any questions in regards to the participation in this study, please contact Malissa Hauser or Bev Johnson at the Physical Therapy Department. The number is (701) 777-2831. Your participation is very important to the success of this research project and is greatly appreciated. Thank you very much for your time and cooperation.

Sincerely,

Malissa Hauser, S.P.T.

encl.
ACL FOLLOW-UP QUESTIONNAIRE

Occupation: ____________________________
Surgery Date: ____________________________
Reference Number: ____________________________

INSTRUCTIONS: For each of the following questions, choose the response which best describes the condition of your knee following anterior cruciate ligament (ACL) reconstructive surgery.

1. Do you experience pain in your knee? (Place an "X" in the blank above the number which best describes the frequency of your knee pain relative to the two extremes)

NEVER

DAILY, EVEN AT REST

0 1 2 3 4 5 6 7 8 9 10

2. The best way to describe your knee pain is:

- no pain
- inconsistent and slight
- constant pain
- marked after walking < 1 1/4 miles per day
- marked after walking > 1 1/4 miles per day
- marked only after strenuous activity or exercise

3. How bad is your pain at its worst? (Place an "X" in the blank above the number which best describes your knee pain relative to the two extremes)

NONE

SEVERE, EVEN AT REST

0 1 2 3 4 5 6 7 8 9 10

4. Which of the following activities cause knee pain? (Check ALL that apply)
- resting
- sitting
- standing
- jumping
- walking
- running
- kneeling
- squatting
- ascending/descending stairs
- end range of bending or straightening knee
- pivoting or cutting
- I do NOT have pain with any of these activities

5. Location of pain?

- inner side of knee
- outer side of knee
- back of knee
- front/kneecap
- all over
- no pain

6. Type of pain?

- sharp
- aching
- throbbing
- burning
- none

7. Method of pain relief?

- no knee pain presently
- rest
- medication
- not participating in sports
- reduced overall activity level
- no pain relief possible

8. Kneecap grinding?

- yes
- no
9. Knee stiffness?
   - none
   - in the mornings
   - after sitting long periods of time
   - during cold weather
   - constantly

10. Do you experience swelling in your knee? (Place an 'X' in the blank above the number which best describes how often swelling occurs in your knee relative to the two extremes)

   NEVER       DAILY, EVEN AT REST
   0 1 2 3 4 5 6 7 8 9 10

11. Swelling in your knee occurs:
   - never
   - constantly
   - only after strenuous physical activity
   - during normal, everyday activities

12. The stability of your knee can best be described as:
   - instability occurs constantly with movement
   - instability occurs often with daily activity
   - occasional instability with daily activity
   - no giving way
   - rarely giving way

13. Do you walk with a limp?
   - I do not limp when I walk
   - I limp slightly when I walk
   - I limp severely when I walk

14. Support used when walking?
   - none
   - crutch/cane
   - weight bearing is impossible

15. When you move your knee, which of the following do you experience?
   - no catching or locking
   - catching only
   - locking occasionally
   - locking frequently (> 2 times a week)
   - locked knee that required medical attention

16. How soon after your surgery were you able to return to work activities?
   - 0-3 months
   - 4-6 months
   - 7-12 months
   - 12 months or longer
   - unable to return to work
   - was not working prior to my surgery

17. Choose the response which best describes any change you have had in your work activities since your surgery.
   - no change
   - decreased ability to perform my job since the surgery due to problems associated with my knee
   - unable to work since the surgery due to problems associated with my knee
   - problems with my work activities are unrelated to my knee

18. During stair climbing:
   - I have no problems
   - I take one step at a time
   - I am slightly impaired
   - I find impossible to do

19. During squatting or kneeling:
   - I have no problems
   - I am slightly impaired
   - not possible beyond 90 degrees
   - I find impossible to do
20. How long did you follow the exercise program?
   - 1 year or more
   - 6 months to 1 year
   - 6 weeks to 6 months
   - less than 6 weeks
   - I was not in an exercise program

21. Place an "X" in the blank that best describes your level of sports activity BEFORE your surgery and then place an “✓” in the blank that best describes your level of sports activity AFTER your surgery.

   Before/After
   
   Participates 4-7 days/week (LEVEL 1)
   - jumping, pivoting, or cutting sports (basketball, volleyball, football, gymnastics, soccer)
   - running, twisting, or turning sports (tennis, racquetball, wrestling, hockey, skiing)
   - no running, twisting, or jumping sports (bicycling, swimming)

   Participates 1-3 days/week (LEVEL 2)
   - jumping, pivoting, or cutting sports
   - running, twisting, or turning sports
   - no running, twisting, or jumping sports

   Participates 1-3 times/month (LEVEL 3)
   - jumping, pivoting, or cutting sports
   - running, twisting, or turning sports
   - no running, twisting, or jumping sports

   No sports participation (LEVEL 4)
   - perform daily activities without problems
   - perform daily activities with moderate problems
   - perform daily activities with severe problems

22. How often do you use a knee brace?
   - continuously
   - during all physical activities/sports
   - occasionally during physical activities/sports
   - at work
   - not at all

23. How would you rate the overall condition of your knee at the present time?
   - Excellent (Full, unlimited return to all activities and sports without problems)
   - Good (Slight modifications and limitations to activities and sports but can participate)
   - Fair (Moderate limitations that affect activities of daily living and no sport participation)
   - Poor (Significant limitations that affect entire lifestyle)

24. Did you ever reinjure your knee after surgery?
   - yes
   - no
   If yes, please explain
   ____________________________
   ____________________________
   ____________________________

25. Any additional surgery required?
   - yes
   - no
   If yes, please explain
   ____________________________
   ____________________________
   ____________________________

26. If you had the choice would you still choose to have reconstructive surgery again?
   - yes
   - no

Please include any additional comments or suggestions.

________________________________________

Thank you.
**ACL FOLLOW-UP QUESTIONNAIRE**

<table>
<thead>
<tr>
<th>Occupation:</th>
<th>Surgery Date:</th>
<th>Reference Number:</th>
</tr>
</thead>
</table>

**INSTRUCTIONS:** For each of the following questions, choose the response which best describes the condition of your knee following anterior cruciate ligament (ACL) reconstructive surgery.

1. Do you experience pain in your knee? (Place an 'X' in the blank above the number which best describes the frequency of your knee pain relative to the two extremes)

<table>
<thead>
<tr>
<th>NEVER</th>
<th>DAILY, EVEN</th>
<th>AT REST</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. The best way to describe your knee pain is:
   - 10:1 no pain
   - 5:7 inconsistent and slight
   - 3:4 constant pain
   - 10:1 marked after walking < 1 1/4 miles per day
   - 3:4 marked after walking > 1 1/4 miles per day
   - 2:3 marked only after strenuous activity or exercise

3. How bad is your pain at its worst? (Place an 'X' in the blank above the number which best describes your knee pain relative to the two extremes)

<table>
<thead>
<tr>
<th>NONE</th>
<th>SEVERE, EVEN</th>
<th>AT REST</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Which of the following activities cause knee pain? (Check ALL that apply)
   - 3:3 resting
   - 10:4 sitting
   - 10:4 standing
   - 4:4 jumping
   - 4:4 running
   - 4:4 walking
   - 10:4 kneeling
   - 10:4 squatting
   - 10:4 ascending/descending stairs
   - 10:4 end range of bending or straightening knee
   - 10:4 pivoting or cutting
   - 10:4 I do NOT have pain with any of these activities

5. Location of pain?
   - inner side of knee
   - outer side of knee
   - back of knee
   - front/kneecap
   - all over
   - no pain

6. Type of pain?
   - sharp
   - aching
   - throbbing
   - burning
   - none

7. Method of pain relief?
   - no knee pain presently
   - rest
   - medication
   - not participating in sports
   - reduced overall activity level
   - no pain relief possible

8. Kneecap grinding?
   - yes
   - no
9. Knee stiffness?
   13.3 none
   22.2 in the mornings
   56.7 after sitting long periods of time
   51.1 during cold weather
   4.4 constantly

10. Do you experience swelling in your knee? (Place an "X" in the blank above the number which best describes how often swelling occurs in your knee relative to the two extremes)
   NEVER
   DAILY, EVEN AT REST
   28.9 | 36.7| 11.1| 16.0| 16.7 | 17.8 | 14.4| 11.1| 3.3 | 1
   0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10

11. Swelling in your knee occurs:
   44.9 never
   3.4 constantly
   37.1 only after strenuous physical activity
   14.6 during normal, everyday activities

12. The stability of your knee can best be described as:
   1.1 instability occurs constantly with movement
   3.3 instability occurs often with daily activity
   18.9 occasional instability with daily activity
   54.4 no giving way
   22.2 rarely giving way

13. Do you walk with a limp?
   76.7 I do not limp when I walk
   21.1 I limp slightly when I walk
   2.2 I limp severely when I walk

14. Support used when walking?
   100.0 none
   crutch/cane
   weight bearing is impossible

15. When you move your knee, which of the following do you experience?
   70.0 no catching or locking
   22.2 catching only
   8.9 locking occasionally
   1.1 locking frequently (>2 times a week)
   locked knee that required medical attention

16. How soon after your surgery were you able to return to work activities?
   63.6 0-3 months
   22.1 4-6 months
   11.7 7-12 months
   1.3 12 months or longer
   1.3 unable to return to work
   was not working prior to my surgery

17. Choose the response which best describes any change you have had in your work activities since your surgery.
   84.5 no change
   13.3 decreased ability to perform my job since the surgery due to problems associated with my knee
   unable to work since the surgery due to problems associated with my knee
   problems with my work activities are unrelated to my knee

18. During stair climbing:
   77.8 I have no problems
   12.2 I take one step at a time
   10.0 I am slightly impaired
   I find impossible to do

19. During squatting or kneeling:
   25.6 I have no problems
   66.7 I am slightly impaired
   3.3 not possible beyond 90 degrees
   4.4 I find impossible to do
20. How long did you follow the exercise program?
   - 47.2 1 year or more
   - 33.7 6 months to 1 year
   - 18.0 6 weeks to 6 months
   - 1.1 less than 6 weeks
   - _ I was not in an exercise program

21. Place an “X” in the blank that best describes your level of sports activity BEFORE your surgery and then place an “✓” in the blank that best describes your level of sports activity AFTER your surgery.

<table>
<thead>
<tr>
<th>Before/After</th>
<th>Participates 4-7 days/week (LEVEL 1)</th>
<th>Participates 1-3 days/week (LEVEL 2)</th>
<th>Participates 1-3 times/month (LEVEL 3)</th>
<th>No sports participation (LEVEL 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>51.2 18.5</td>
<td>jumping, pivoting, or cutting sports (basketball, volleyball, football, gymnastics, soccer)</td>
<td>running, twisting, or turning sports (tennis, racquetball, wrestling, hockey, skiing)</td>
<td>no running, twisting, or jumping sports (bicycling, swimming)</td>
<td>Participates 1-3 days/week (LEVEL 2)</td>
</tr>
<tr>
<td>6.1 3.7</td>
<td>jumping, pivoting, or cutting sports</td>
<td>running, twisting, or turning sports</td>
<td>no running, twisting, or jumping sports</td>
<td>Participates 1-3 times/month (LEVEL 3)</td>
</tr>
<tr>
<td>8.5 23.5</td>
<td>no running, twisting, or jumping sports (bicycling, swimming)</td>
<td>Participates 1-3 days/week (LEVEL 2)</td>
<td>running, twisting, or turning sports</td>
<td>No sports participation (LEVEL 4)</td>
</tr>
<tr>
<td></td>
<td><strong>Participates 1-3 days/week (LEVEL 2)</strong></td>
<td><strong>Participates 1-3 times/month (LEVEL 3)</strong></td>
<td><strong>No sports participation (LEVEL 4)</strong></td>
<td><strong>No sports participation (LEVEL 4)</strong></td>
</tr>
<tr>
<td>17.1 17.3</td>
<td>jumping, pivoting, or cutting sports</td>
<td>running, twisting, or turning sports</td>
<td>no running, twisting, or jumping sports</td>
<td>perform daily activities without problems</td>
</tr>
<tr>
<td>4.9 7.4</td>
<td>running, twisting, or turning sports</td>
<td>no running, twisting, or jumping sports</td>
<td><strong>No sports participation (LEVEL 4)</strong></td>
<td>perform daily activities with moderate problems</td>
</tr>
<tr>
<td>3.7 12.3</td>
<td>no running, twisting, or jumping sports</td>
<td><strong>No sports participation (LEVEL 4)</strong></td>
<td><strong>No sports participation (LEVEL 4)</strong></td>
<td>perform daily activities with severe problems</td>
</tr>
<tr>
<td>1.2 1.2</td>
<td><strong>No sports participation (LEVEL 4)</strong></td>
<td><strong>No sports participation (LEVEL 4)</strong></td>
<td><strong>No sports participation (LEVEL 4)</strong></td>
<td><strong>No sports participation (LEVEL 4)</strong></td>
</tr>
<tr>
<td>1.2 1.2</td>
<td><strong>No sports participation (LEVEL 4)</strong></td>
<td><strong>No sports participation (LEVEL 4)</strong></td>
<td><strong>No sports participation (LEVEL 4)</strong></td>
<td><strong>No sports participation (LEVEL 4)</strong></td>
</tr>
</tbody>
</table>

22. How often do you use a knee brace?
   - continuously
   - 24.4 during all physical activities/sports
   - 34.4 occasionally during physical activities/sports
   - 44.4 at work
   - 40.0 not at all

23. How would you rate the overall condition of your knee at the present time?
   - 25.6 Excellent (Full, unlimited return to all activities and sports without problems)
   - 58.9 Good (Slight modifications and limitations to activities and sports but can participate)
   - 10.0 Fair (Moderate limitations that affect activities of daily living and no sport participation)
   - 5.6 Poor (Significant limitations that affect entire lifestyle)

24. Did you ever reinjure your knee after surgery?
   - 15.6 yes
   - 84.4 no
   If yes, please explain
   
   
25. Any additional surgery required?
   - 21.3 yes
   - 78.7 no
   If yes, please explain
   
   
26. If you had the choice would you still choose to have reconstructive surgery again?
   - 89.9 yes
   - 10.1 no
   Please include any additional comments or suggestions.
   
   
Thank you.
APPENDIX D
COMMENTS TO ACL FOLLOW-UP QUESTIONNAIRE

DEFINITIONS

Overall Condition - How the patient rated the knee at the present time
Reinjure - Did the patient ever reinjure the knee after surgery
Additional Surgery - Any additional surgery required
Choice - Would the patient still choose to have reconstructive surgery again

* Some sensitivity to cold, especially during winter months-icy conditions. I utilize a knee brace, a slip on foam type of knee brace during work (police work), or during heavy lifting, or other strenuous activities to ensure stability of the knee. I do no participate in downhill winter skiing, nor water skiing (more psychological than physical). Extended periods of sitting (i.e. long periods of driving) become uncomfortable with knee brace and cuts off circulation to the knee.

Overall Condition: Excellent
Reinjure: No
Additional Surgery: No
Choice: Yes

* I was in high school when I had surgery. My knee makes popping and cracking noises daily.

Overall Condition: Good
Reinjure: No
Additional Surgery: Yes. Built up scar tissue and knee would not bend past 90 degrees. (Arthroscopic surgery to break down scar tissue)
Choice: Yes, only if absolutely needed! That was the most pain I have ever experienced!!

* My knee is totally shot. I need a new one but I'm too young for a new knee.

Overall Condition: Poor
Reinjure: Yes. I have had 4 surgeries and in my last one a dog ran into my knee and that caused a surgery.
Additional Surgery: Yes. I had a ACL and 3 arthroscopies and Dr. ______ wants to do another ACL but I won't do it.
Choice: No. I feel Dr. ______ did a fine job but my knee was very bad.

* I tried running and it just didn't work because of the knee pain. I guess that's not a real love loss though because I don't like running anyway.

I guess as humans we adapt and I can tell I don't go gung-ho with crazy things like running down stairs or doing things that would jeopardize my operated knee. I figure I'd really like to keep it intact. No more surgeries for me! I refuse to go water skiing (scared I'll tear my ACL again).

This was kind of a cool survey. When I hurt my knee my gymnastics career, which I loved dearly, was over in a split second. Since I tore cartilage and my ACL, I decided that it could never be back to 100% because even when my ACL was replaced, the
cartilage was not. Anyway, nobody really understands what a loss it is to tear knee ligaments, especially when you were so active in things like gymnastics, something that requires total control. People who never did sports like that don't understand. When they see you walking they think everything's OK.

I'd like to say that Dr. _____ is a great physician and orthopedic surgeon. We opted to go with my patellar tendon vs. a synthetic material so I knew that my body would accept it and also, the chances of having surgery again in 20 years with the synthetic one was a possibility of which I didn't want to chance.

**Overall Condition:** Good

**Reinjure:** No

**Additional Surgery:** No

**Choice:** Yes

* No comments

**Overall Condition:** Good

**Reinjure:** No

**Additional Surgery:** No

**Choice:** Yes, only if it was badly torn.

* Knee still hurts when I walk, pops a lot, and when it's cold out is when my knee really hurts.

**Overall Condition:** Good

**Reinjure:** Yes. Hurt it in the Bison game in 1992.

**Additional Surgery:** No

**Choice:** Yes

* Nobody wanted to admit it was their fault for the infection. I know an old guy that had it happen (to him) but didn't have surgery and doesn't have any problems whatsoever.

**Overall Condition:** Poor

**Reinjure:** No

**Additional Surgery:** Yes. Suffered staff infection, got real sick and had to have it cleaned out.

**Choice:** No

* I was satisfied with my surgery but I do experience some minor clicking and popping in my knee. Also, I am limited in doing certain activities (sports).

**Overall Condition:** Good

**Reinjure:** Yes. Approximately one year later I tore cartilage in my knee I had my ACL on. It was hurt when I over extended my knee.

**Additional Surgery:** Yes. Arthroscopic surgery.

**Choice:** Yes, only if I absolutely had to.
* Dr. _____ did an excellent job regarding my knee and leg. However, I think a smaller screw and staple should be invented for smaller legs then they may not have to be removed after an ACL has been reconstructed. Prevention of injury is still the best.

Basketball injury-I have been highly active both before and after the injury. I do not participate in any contact sports that require cutting, pivoting, jumping, etc. Surgery on leg in 1993 has kept me out of running activities also.

Best of luck to you on your research project. You may call if you have any other questions.

Overall Condition: Good
Reinjure: Yes. The screw and staple were bothersome so had them removed. After the staple was removed, the femur broke. The break was just above the knee.
Additional Surgery: Yes. Surgically repaired broken femur by holding it together with a plate and 9 screws.
Choice: Yes. I had no choice.

* I feel my last surgery was a lot better than my first. Also, my doctor was an excellent doctor. I would recommend him to anyone! I wish there were more like him in this world.

Overall Condition: Good
Reinjure: Yes. Baling hay, I twisted it.
Additional Surgery: No
Choice: Yes

* No comments

Overall Condition: Poor
Reinjure: Yes. Bumping, even my drawer at work hurts my knee if I bump it. Nothing to where I need to see a doctor.
Additional Surgery: No
Choice: Yes. I would have no choice since everything was blown out.

* I would seriously consider the severity of my injury before deciding to have the surgery again. It's a very strenuous and painful surgery. The recovery takes a lot of time and dedication as well.

Overall Condition: Excellent
Reinjure: No
Additional Surgery: No
Choice: Undecided

* My exercise allowed is limited. But I haven't fallen in 2 1/2 years. I exhibit a lot of pain but I don't know how much of it is arthritis. It was found during the surgery. I have had 5 surgeries on this knee, so some questions were difficult. I hope you can understand. I have gone from 5 miles running a day to barely being able to be on it 3 hours a day. VOC rehab is retraining me for another career. I know it probably doesn't matter but I am only 26.
**Overall Condition:** Fair. Since surgery, I have not played ball in 2 1/2 years. I used to play 7 days per week.
- **Reinjure:** No
- **Additional Surgery:** No
- **Choice:** Yes

*I'd have the surgery again if I had to but I wouldn't want my worst enemy to go through it.*

**Overall Condition:** Excellent
- **Reinjure:** No
- **Additional Surgery:** No
- **Choice:** Yes

*No kneeling because part of the tendon was removed and it bothers my knee cap. I can only squat for short periods. I don't do sports now, only rarely. Dr. _____ did an excellent job and if I worked out, I would be able to do all sports again but I only choose not to.*

**Overall Condition:** Good
- **Reinjure:** No
- **Additional Surgery:** Yes. I had the staple and screws removed because my body reacted to them. I was able to go back to work 3 days later.
- **Choice:** Yes

*Other than the insurance problem I've had, I would highly recommend surgery to anyone. Make sure you have insurance clearance IN WRITING before surgery.*

**Overall Condition:** Fair
- **Reinjure:** No
- **Additional Surgery:** No
- **Choice:** Yes

*Dr. _____ did a great job. Surgery was less painful than expected. _____ is a great therapy center and I would recommend it to anyone who needs it. Wish I would have gotten to see the doctor within 1 week after injury. I had to wait 1 1/2 months.

Went to other doctors, first one common doctor didn't know anything about knees. Said it will be fine after the swelling. I didn't believe him. Can't believe he is a doctor, didn't know anything about ACL or even how to test for broken ligaments. Second doctor from _________ that studies this field said there was a broken ACL and that I was doing good. He didn't even recommend surgery and that I would be fine in 3 or 4 months. Everything would be back to normal, only need something done if reinjure. Not the case. Dr. _____ was great and guided me in all decisions. His motto was "it's broke it won't fix itself and if left the knee will basically get worse and worse". I recommend surgery to anyone that has a broken ACL by Dr. _____ only and follow therapy closely because it's half of the surgery's success. I know people who haven't followed Dr. _____'s advise and will be paying physically for the rest of their lives. Thank God I am not one of those people.*
I was behind in getting surgery and but follow therapy closely 110%. Medical personal need to show more statistics and push patients to get their ACL fixed. It's worth it. Glad I could help. I am willing to answer any questions that will help you and others with your (ACL) research.

* **Overall Condition:** Good  
* **Reinjure:** No  
* **Additional Surgery:** No  
* **Choice:** Yes

* Surgery and rehab went well. I feel occasional discomfort on the tibial tuberosity and also medially. I played basketball 3 days a week starting in January (5 months post-op). I experienced a lot of fatigue and some pain because I believe I played too much. A lot better now.

  * **Overall Condition:** Good  
  * **Reinjure:** No  
  * **Additional Surgery:** No  
  * **Choice:** Yes

* The surgery was something that I wouldn't put my worst enemy through. It was hell!

  * **Overall Condition:** Good  
  * **Reinjure:** No  
  * **Additional Surgery:** No  
  * **Choice:** No

* I'm very loose jointed and have a loose connective tissue disorder along with a lack of collagen present. I've been on Vitamin C therapy for 3 years and there is nothing left to do to help with my current complications.

  * **Overall Condition:** Good  
  * **Reinjure:** Yes. Stretched the posterior lateral ligament.  
  * **Additional Surgery:** Yes. Tightening of posterior lateral ligament.  
  * **Choice:** Yes

* To many problems to list. This really sucks!

  * **Overall Condition:** Poor  
  * **Reinjure:** Yes. Infections-3 times after ACL surgery.  
  * **Additional Surgery:** Yes. Hardware removal.  
  * **Choice:** Yes

* Knee gives out occasionally when walking. Standing long periods is painful and aching. Almost feels like it extends backward too far when standing. Activity level is going okay. I wish water skiing and snow skiing were easier. I am almost scared for fear of reinjury to be too active. I am glad I had the surgery because of the improvement of life compared to after injury. I encourage doctors to test for ACL problems more quickly
than they did for me. I had therapy without surgery and went back and reinjured it before they did surgery.

The physical therapist and Dr. _____ were very cooperative. I do have some pain occasionally and especially when weather changes occur, which I feel is related to arthritis condition. Overall outcome of surgery I feel was satisfactory. Dr. _____ is very good.

**Overall Condition:** Good

**Reinjure:** Yes. Jumped into a pool and jammed my leg 4 months following surgery. Skiing downhill in 1991, pain when movement back and forth down the hills. Twisted knee when fell on mountain. Never checked out. Swelling and stiffness lasted a couple days, then fine.

**Additional Surgery:** No

**Choice:** Yes

* The surgery helped me go back to play sports. I have had no problems such as pain, infection, or others since my surgery. I have just become slower those nine months of recovery with hardly any exercise for the first couple of months.

**Overall Condition:** Good. No problems, just slower.

**Reinjure:** No

**Additional Surgery:** No

**Choice:** Yes

* Knee stiffness depends on the day and how well my meds are working at the time. To a small degree, there's always still some swelling constantly. I had a synovectomy. My surgery was not due to a sports related injury. I have rheumatoid arthritis. How my knee feels now mostly has to do with how well my medication is working at the time, as well as to how physically active I am. The surgery did greatly reduce my pain and the swelling, even now 4 years later.

**Overall Condition:** Fair

**Reinjure:** No

**Additional Surgery:** No

**Choice:** Yes, if I had to. Maybe.

* My knee is not nearly as good as my good knee, but I can still participate in activities.

**Overall Condition:** Good

**Reinjure:** No

**Additional Surgery:** No

**Choice:** Yes

* My knee, I think, will be close to 100% with time. The other knee was done also in 1988 and is excellent.

**Overall Condition:** Good

**Reinjure:** No

**Additional Surgery:** No
Choice: Yes

* I'm very pleased with Dr. _____'s work and recommend him whenever I can.

Overall Condition: Good
Reinjure: No
Additional Surgery: No
Choice: Yes

* When pivoting or cutting, not pain just uneasiness but feels strong enough. Always looks a little swollen. Feels unstable during any sideways movement, but does not give out though. I can't kneel on that screw!

I might have been able to get away with just wearing a brace and quitting certain sports.
Overall Condition: Good
Reinjure: No
Additional Surgery: No
Choice: Yes?

* I use knee pads if I have to do much kneeling. The first two years after surgery my knee was in excellent condition. I did not return to sports because I didn't want to risk reinjury. I did continue weight training every other day. The last two years, my knee has been giving me more trouble. I don't run on it much because I experience pain the following day. I do continue regular weight training to keep the muscles around the joint strong. When my injury occurred there was some cartilage damage. The pain may be from that but I should go see Dr. _____ to find out if anything can be done.

Overall Condition: Good
Reinjure: No
Additional Surgery: No
Choice: Yes

* Thanks to Dr. _____, I'm almost as good as new. Also thanks to (physical therapist) from ________.

Overall Condition: Excellent
Reinjure: No
Additional Surgery: No
Choice: Yes

* I found out in December of 1992 that I have a hypothyroid condition. I believe this has been the case for years (before injury) and it has greatly affected by ability to regain my muscle strength. I do believe I will return to full activity (skiing, etc.) as I get the weight off and get the muscle strength back.

Overall Condition: Good
Reinjure: No
Additional Surgery: Yes. In June of 1989, I had surgery to remove scar tissue to regain movement.
Choice: Yes

* After suffering a catastrophic non-fatal knee injury with a 50/50 chance of amputation going into surgery, I couldn't be much happier with the condition my knee is in!
Overall Condition: Good
Reinjure: No
Additional Surgery: Yes. Dislocated knee caused peroneal nerve to sever completely in half. Posterior tib transplant necessary to restore ability to lift foot up.
Choice: Yes

* It is important to keep range of motion right after surgery. I was not told that after I left the hospital and I believe that my rehab was harder because I had to break scar tissue.
Overall Condition: Good
Reinjure: No
Additional Surgery: No
Choice: Yes

* I feel my knee swells on the inside causing the pain and limited motion.
Overall Condition: Good
Reinjure: No
Choice: Yes

* Even though it hurts now, it hurt a lot more before.
Overall Condition: Poor
Reinjure: No
Additional Surgery: No
Choice: Yes

* My knee is weak. It gets very sore and tired. During cold weather it aches at night and will sometimes throb. I think I should be tested again or one should have regular yearly check-ups. I need to get back on a weight lifting program.
Overall Condition: Good
Reinjure: Yes. I had 2 scopes previous to my reconstructive surgery. After my reconstruction, no.
Additional Surgery: Yes
Choice: Yes

* I feel that therapy program is what brought me back to full usage and it is still necessary to continue exercise plan to keep mobility.
Overall Condition: Excellent
Reinjure: No
**Additional Surgery:** Yes. Removed screw  
**Choice:** Yes

* I notice now that my knee is weak and I baby it too much so we joined the ____ to start doing weights. Sticking with the exercise program is important.  
**Overall Condition:** Good  
**Reinjure:** No  
**Additional Surgery:** No  
**Choice:** Yes

* I am very happy with the way things turned out. I am grateful to everyone concerned.  
**Overall Condition:** Excellent  
**Reinjure:** No  
**Additional Surgery:** No  
**Choice:** Yes

* Slight tenderness in knee cap area but does not limit my activities.  
**Overall Condition:** Excellent  
**Reinjure:** No  
**Additional Surgery:** No  
**Choice:** Yes

* I have had ACL surgery on both knees so I do not participate in contact sports (basketball, volleyball, softball, skiing) as my risk factor is high for injury. It is sometimes difficult but I am learning to adjust.  
**Overall Condition:** Good  
**Reinjure:** No  
**Additional Surgery:** No  
**Choice:** Yes

* I was a bit disappointed in myself while in the exercise program because I only gave about 75-90%. But I haven't had any problems and it feels great. It is difficult to explain what it feels like, but I wouldn't call it pain. A lot happens at random.  
**Overall Condition:** Excellent  
**Reinjure:** No  
**Additional Surgery:** No  
**Choice:** Yes

* Gained lots of weight (70 pounds). Do not engage in competitive sports now. Feel weakness in entire leg which radiates from knee (only at times).  
**Overall Condition:** Good  
**Reinjure:** No  
**Additional Surgery:** No  
**Choice:** Yes
* Recovery prospects and level of returned physical capacities were overly optimistic.
  Overall Condition: Fair
  Reinjure: No
  Additional Surgery: No
  Choice: No, unless symptoms became unbearable.

  * The second reconstruction surgery was much easier to go through. It didn't seem as painful and rehab was much easier.
  Overall Condition: Good (L) and Fair (R)
  Reinjure: No (L) and Yes (R). More torn cartilage (R). Went in for a scope two years after reconstruction.
  Additional Surgery: No (L) and Yes (R). Had my pin and staple removed 2 years after reconstruction. It was causing pain.
  Choice: Yes

  * I have severe grinding in my knee but the only time it bothers is to squat or if going up many flights of stairs. I am fully participating in all sports I was before with no problems. I am planning on going into P.T. so if you want any further information, I'd be glad to help.
  Overall Condition: Excellent
  Reinjure: Yes. Possible cartilage tear but no problems since (6 months ago).
  Additional Surgery: No
  Choice: Yes

  * It worked well for me, but it wasn't the most pleasant thing I've ever done.
  Overall Condition: Excellent
  Reinjure: No
  Additional Surgery: Yes. To cut scar tissue for mobility.
  Choice: Yes

  * I would do it again! Never had a lot of pain. You have to faithfully do the P.T. afterwards!
  Overall Condition: Good
  Reinjure: No
  Additional Surgery: No
  Choice: Yes

  * Before I had ACL reconstruction I had two arthroscopic surgeries. I feel I should have had ACL reconstruction on the first injury. It would have saved a great deal of pain and money. But, even after 3 surgeries I went back to play Collegiate Hockey.
  Overall Condition: Good
  Reinjure: Yes. Not major though. Didn't see a doctor for it. Routine hockey injury.
  Additional Surgery: No
Choice: Yes

* No comments
Overall Condition: Good
Reinjure: No
Additional Surgery: Yes. Scoped to try and clean out scar tissue so that my leg would straightened.
Choice: Yes

* The rehab was hard and long. I'm still trying to rebuild the muscles. I am finally starting to gain confidence in my knee. I don't know how to answer question #26 (whether or not have surgery again) because I don't know what the condition of my knee would be if I didn't have the surgery. I did not live close to a rehab clinic so my progress was slow.
Overall Condition: Good
Reinjure: No
Additional Surgery: No
Choice: Undecided

* The biggest problem that I have would have to be my weight. I was 245 pounds before I injured my knee. Not being active in sports, I have now put on 100 pounds and I know my knee would feel better without the extra weight. I can't kneel on that knee.
Overall Condition: Good
Reinjure: No
Additional Surgery: No
Choice: Yes

* I was pregnant when my injury occurred, so I didn't have surgery until 9 months later. Therefore, I had to have lots of the bone surface shaved from where they were rubbing together. My recovery then took longer because of those circumstances. My knee is very stable, but I still do not have my full range of motion. It hurts to kneel directly on the knee cap or crawl.
Overall Condition: Good
Reinjure: No
Additional Surgery: Yes. I couldn't get back to full extension, so I had a scope to get rid of scar tissue build up. I still am about 5 degrees shy of full extension and I have no feeling in my big toe.
Choice: No. That's hard to answer for sure. I know I didn't walk with a limp before.

* No comments
Overall Condition: Excellent
Reinjure: No
Additional Surgery: No
Choice: I had no choice. The ACL, MCL, meniscus and cartilage were destroyed. It was a question of being able to function. If I could have been able to walk normally and wear a brace to participate in sports, I would have avoided surgery.

* I am very pleased with the surgery, therapy, and recovery. I don't run anymore, but I do walk and cycle. My range of motion is excellent. My strength is back. I am trying to stay slim and exercise some to maintain my leg strength.

**Overall Condition:** Good

Reinjury: No

**Additional Surgery:** No

Choice: Yes

* I had injured my knee 11 years before surgery, so I never participated in my sports with pivoting, twisting, downhill skiing, etc. After reinjury and since my surgery, I still do not participate in twisting, rotating, skiing, by choice. I didn't buy a brace.

**Overall Condition:** Excellent

Reinjury: No

**Additional Surgery:** No

Choice: Yes

* No comments

**Overall Condition:** Poor

Reinjury: No

**Additional Surgery:** Yes. My knee has to be completely replaced.

Choice: Yes

* I feel if I would have stuck out therapy I would be better. After first surgery I did rehab for 5 months then played basketball in fall of my senior year. My case might have other implications. Joints may have had looseness above normal which could have played a role in ACL damage. As far as surgery, it enables me to do my job, walk my dog, and do the things I enjoy to do. Like my doctor said "Golf is a game that takes a lot of practice".

**Overall Condition:** Fair

Reinjury: Yes. (Right knee after first surgery) Tore cartilage and scar tissue during basketball, wearing Leneox Hill brace.

**Additional Surgery:** Yes. Scoped right knee

Choice: Yes

* Left knee shows more problems. I wish something could have helped the cartilage heal better/faster. I think the cartilage tear affected the outcome.

**Overall Condition:** Excellent

Reinjury: Yes. Right knee was scoped at the time of left knee surgery. Scar tissue as cleaned up.

**Additional Surgery:** No

Choice: Yes
* Still numb around the front part. Very sensitive when (or if) I kneel. No real important problems. Surgery and rehab went very well. Can always tell something was worked on though. Quite satisfied with all aspects of ACL reconstruction.

Overall Condition: Excellent
Reinjure: No
Additional Surgery: No
Choice: Yes

* No comments

Overall Condition: Poor (I am between fair and poor)
Reinjure: No
Additional Surgery: No
Choice: No. I would opt for the scope, cleaning and exercise first, then maybe consider surgery if that did not work. I would have liked an MRI taken at first so I could have had a baseline postoperatively. I would then have also known the true extent of my problem before surgery so I could be better prepared for my disability. P.S. I feel I am still improving however.

* No comments

Overall Condition: Excellent
Reinjury: No
Additional Surgery: Yes. I might need it scoped after the season to remove scar tissue.
Choice: Yes
APPENDIX E
Multiple Regression

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<thead>
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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tr>
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* indicates significance at .05 level.

Surgical Procedure 1: Partial Medial Meniscectomy
2: Partial Lateral Meniscectomy
3: Medial Meniscus Repair
4: Lateral Meniscus Repair
5: Posterior Lateral Augmentation
6: Medial Collateral Ligament Repair
References


