Current State of Care for Pediatric ACL Ruptures in the Netherlands: A Survey

Martijn Dietvorst, MD1, Max Reijman, PhD2, Rein van Zutven, BSc1, Michel P. J. van den Bekerom, MD, PhD3, Duncan E. Meuffels, MD, PhD2, Matthijs P. Somford, MD, PhD4, Rob P. A. Janssen, MD, PhD1,5,6

1 Department of Orthopaedic Surgery, Máxima Medical Center, Eindhoven, the Netherlands
2 Department of Orthopaedic Surgery, Erasmus MC, University Medical Center Rotterdam, Rotterdam, the Netherlands
3 Department of Orthopaedic Surgery, Onze Lieve Vrouwe Gasthuis, Amsterdam, the Netherlands
4 Department of Orthopaedic Surgery, Rijnstate Hospital, Arnhem, the Netherlands
5 Department of Value-Based Health Care, Fontys University of Applied Sciences, Eindhoven, the Netherlands
6 Orthopaedic Biomechanics, Department of Biomedical Engineering, Eindhoven University of Technology, the Netherlands

Address for correspondence Martijn Dietvorst, MD, Department of Orthopaedic Surgery, Máxima Medical Center, Dominee Theodor Fliednerstraat 1, 5631 BM Eindhoven, the Netherlands (e-mail: martijndietvorst@gmail.com).

Abstract

The management of anterior cruciate ligament (ACL) injuries in the skeletally immature patient is an area of controversy. The purpose of this survey is to inventory the current state of care for pediatric ACL injuries in the Netherlands. This survey was conveyed by e-mail among all members of the Dutch Arthroscopy Society (Nederlandse Vereniging van Arthroscopie [NVA]) and promoted on the Web site of the NVA. It was developed by the scientific committee of the NVA by a consensus meeting discussing relevant topics in pediatric ACL injuries. All members of the NVA received the survey (n = 540). A total of 158 (29%) members responded to the survey, of which 143 were completed. A total of 126 responses were analyzed after exclusion. The main finding of this survey is that 78% of the respondents tend to treat children with open physes nonoperatively, while 65% tend to treat children with closed physes operatively. The most frequently performed procedure is the transphyseal reconstruction. Many considerations were involved in choosing operative treatment. The postoperative follow-up period varies from less than 1 year (24%) until fully grown (27%). In conclusion, this survey shows that the current state of care for pediatric ACL injuries is variable and a matter of debate in the Netherlands. Although the response rate seems low, this survey provides an overview of the opinions of specialized orthopaedic surgeons in the Netherlands. The results of this survey led to the development of the national registry for pediatric ACL in the Netherlands. The level of evidence for this study is V.
The management of anterior cruciate ligament (ACL) injuries in the skeletally immature patient is an area of controversy.\textsuperscript{1,2} Both operative and nonoperative treatments can result in complications, such as physeal damage resulting in growth disturbances postoperatively or secondary damage to the meniscus or cartilage in case of nonoperative treatment. Opinions on whether pediatric ACL injuries should primarily be treated operatively or nonoperatively are still divided.\textsuperscript{3–5} Should all children with open physes be treated nonoperatively until the physes are closed, or is surgical treatment a viable option in skeletally immature children? In case of operative treatment, which surgical technique should be used to ensure optimal biomechanical positioning of the graft and to prevent physeal injury and graft failure? Which considerations play a role in indicating surgical treatment? What are the formats and requirements for follow-up? All these items are a matter of debate due to a lack of solid scientific knowledge.\textsuperscript{3}

During the past two decades, there were an increasing number of studies on ACL injuries in skeletally immature children.\textsuperscript{6} These studies suggest an increasing trend of ACL injury rates in children, which is also described in a population-based study over a period from 2005 to 2015 in Australia.\textsuperscript{7} Whether the incidence is truly increasing because of higher sports participation or whether there is an increase in clinical awareness and advances in diagnostic methods is a matter of debate.\textsuperscript{6,7}

Studies on the management of children with ACL injury present a low level of evidence.\textsuperscript{8} The gold standard of management of skeletally immature children with an ACL rupture has still to be determined and therefore “the best treatment” for the individual skeletally immature patient is so far unknown.\textsuperscript{2} A recent, descriptive study by Ekås et al showed that \textasciitilde 50% of the children with primary nonsurgical treatment may cope well and have healthy menisci through adulthood.\textsuperscript{9} The other half may need delayed ACL reconstruction.\textsuperscript{9} Treatment algorithms for ACL ruptures in skeletally immature children vary around the world and are mainly experience-based.\textsuperscript{5,6,10–12} With the possible increasing numbers of these injuries and the dilemma that exists between reconstruction and avoidance of physeal injury, an evidence-based approach of this topic is needed.\textsuperscript{2,13}

This study aims to inventory the current state of care for pediatric ACL ruptures in the Netherlands by conducting a survey among members of the Dutch Arthroscopic Association. The ESSKA (European Society of Sports Traumatology, Knee Surgery and Arthroscopy) pediatric ACL monitoring initiative was created by their international survey awareness on the diversity in clinical practice and the authors hoped that it could serve as a catalyst for international collaborations.\textsuperscript{6} The outcomes of this survey can also be used to monitor and give direction to future standards of treatment in the Netherlands. The current national guidelines on ACL injury and treatment in the Netherlands did not include pediatric ACL injuries. The hypothesis therefore is that treatment for skeletally immature children with an ACL injury is heterogeneous.

**Materials and Methods**

**Survey Administration**

The survey was administrated by e-mail to all members of the Dutch Arthroscopy Society (Nederlandse Vereniging van Arthroscopie [NVA]). The Dutch Arthroscopy Society has 540 members, mainly orthopaedic surgeons, but it also includes specialists such as plastic surgeons and veterinarians who do not treat ligament injuries of the knee. Only orthopaedic surgeons are included in the analysis of this survey. A reminder was sent to the members of the NVA who did not respond to the first request to fill in the survey. Besides, the survey was promoted on the Web site of the NVA (https://scopie.org/site/). The responses were analyzed on May 1, 2017 (\textsuperscript{\textbullet} Fig. 1).

**Survey Development**

The scientific committee of the NVA developed the survey by consensus meeting on the relevant topics in pediatric ACL. The scientific committee of the NVA consists of four experienced arthroscopic orthopaedic surgeons and one clinical
Current State of Care for Pediatric ACL Ruptures in the Netherlands

Dietvorst et al.

Table 1 Number of yearly performed ACL reconstructions in general (n = 126)

<table>
<thead>
<tr>
<th>ACL reconstructions per year, n</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>38 (30)</td>
</tr>
<tr>
<td>20–50</td>
<td>39 (31)</td>
</tr>
<tr>
<td>&gt;50</td>
<td>48 (38)</td>
</tr>
<tr>
<td>Unknown</td>
<td>1 (1)</td>
</tr>
</tbody>
</table>

Abbreviation: ACL, anterior cruciate ligament.

Table 3 Number of consultations of children with open physes with ACL injury per year (n = 126)

<table>
<thead>
<tr>
<th>Consultations per year, n</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>100 (79)</td>
</tr>
<tr>
<td>10–50</td>
<td>23 (18)</td>
</tr>
<tr>
<td>&gt;50</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Unknown</td>
<td>1 (1)</td>
</tr>
</tbody>
</table>

Abbreviation: ACL, anterior cruciate ligament.

Table 2 Number of consultations of children (including children with open and closed physes) with ACL injury per year (n = 126)

<table>
<thead>
<tr>
<th>Consultations per year, n</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>64 (51)</td>
</tr>
<tr>
<td>10–50</td>
<td>56 (44)</td>
</tr>
<tr>
<td>&gt;50</td>
<td>4 (3)</td>
</tr>
<tr>
<td>Unknown</td>
<td>2 (2)</td>
</tr>
</tbody>
</table>

Abbreviation: ACL, anterior cruciate ligament.

Results

A total of 540 surveys were sent to all members of the NVA. A total of 158 (29%) members responded on the survey, of which 140 were considered for analysis. After exclusion, 126 responses were included for analysis as is shown in Fig. 1.

How Many Consultations and Reconstructions Are Yearly Performed?

The number of yearly performed ACL-reconstructions in general (regardless of age) is shown in Table 1. The number of consultations by children in general and by children with open physes are shown in Tables 2 and 3.

How Is the Management of Pediatric ACL Injuries?

In case of open physes, 78% of the children with open physeal acr are primarily treated nonoperatively and 22% operatively. In children with a closed physes, 35% are treated primarily nonoperatively and 65% operatively.

In case of nonoperative treatment, the respondents gave different recommendations regarding sports participation (more than one answer allowed). About 70% (n = 88) of the respondents recommended to adjust the type of sports, 41% (n = 51) the level of sports, 43% (n = 54) to wear a brace during sports, and 6% (n = 8) to stop sports participation.

In Case of a Concomitant Symptomatic Meniscal Tear, Does This Influence the Decision-Making in Conservative Treatment?

In case of a concomitant, symptomatic meniscal tear, 25% (n = 32) of the respondents stated that this would not influence treatment. 73% (n = 92) responded that this would influence the choice of treatment, of which 5% (n = 5) refers to another specialist, 13% (n = 12) performs an ACL reconstruction, 30% (n = 28) performs a meniscal repair, and 52% (n = 47) performs an ACL reconstruction and meniscal repair. Two (2%) respondents did not fill in an answer to this question.

Which Factors Are Considered Important as Indication for Surgical Treatment?

Different considerations ranked on importance are shown in Table 4.

Which Surgical Techniques Are Performed in Children with Open Physes?

Of the 126 respondents, 87 (69%) responded to this question in which more than one answer was allowed. In children with open physes, 64% (n = 56) of the respondents perform a transphyseal reconstruction, 28% (n = 24) a physeal sparing reconstruction, 20% (n = 17) a transtibial and femoral physeal sparing procedure, and 11% (n = 10) an extra-articular procedure.

In Case of an ACL Reconstruction of Children with Open Physes, What Is the Duration of the Follow-Up Period?

Of the 126 respondents, 27% (n = 34) follow the children until skeletal maturity, 25% (n = 32) for 1 year postoperatively, 7%...
(n = 9) for 1 to 2 years postoperatively, and 6% (n = 8) for more than 2 years postoperatively. A total of 34% (n = 43) did not complete this question or indicated that the mean follow-up was unknown.

Discussion

The most important finding of this survey is that the majority of the children with open physes are treated nonoperatively while most children with closed physes are treated operatively. In case of operative treatment in a child with open physes, 64% of the respondents chose to perform a transphyseal procedure. Another important finding is that many considerations are involved in indicating operative treatment, of which concomitant injury of the menisci or ligaments is most frequently reported.

The majority of the respondents treat fewer than 10 children with an ACL injury per year, and only 3% of clinicians are consulted by more than 50 children per year. On the basis of these data, one can calculate that there are several hundred ACL injuries in children per year in the Netherlands. The exact incidence of ACL injury in children in the Netherlands is unknown however, and there might be a possibility of overestimation of the number of consultations in this survey.

Nonoperative treatment is the preferred treatment in skeletally immature injured children for 78% of the respondents. Within the pediatric orthopaedic community, opinions are divided whether pediatric ACL injuries should be treated nonoperatively or operatively. Comparing two previous surveys from 2002 and 2015, the proportion (34% vs 59%) of orthopaedic surgeons who advocate operative treatment has almost doubled. In a recent survey by the PRISM (Pediatric Research in Sports Medicine) Society, a case of an 8-year-old child with a complete ACL rupture was presented to the respondents. In this survey, only 3% would treat the child nonoperatively. Reasons for this increase are development of surgical techniques and a stronger belief in beneficial results from surgical treatments. However, the evidence is low; there are neither high-level evidence studies nor studies that compared results from the past to results from the present. In decision-making, weighing risks and benefits between primary nonoperative and primary operative treatment is crucial.

According to the current survey, the most important considerations for operative treatment were concomitant ligament and meniscus injury, followed by the age of the child, the wish to continue to perform sports, and the type and level of sports participation. The preference of the parents and the degree of instability were deemed less relevant. A consensus meeting of the International Olympic Committee in 2018 stated that there are three indications for ACL reconstruction: repairable concomitant injury that require surgery, recurrent and symptomatic giving way after completing rehabilitation, or unacceptable participation restrictions. It is generally accepted that operative treatment reduces the risk of further damage of the menisci or cartilage in case of persistent instability. Nonoperative or delayed operative treatment (3–12 months after trauma) may lead to meniscal injury, due to persistent instability. In conclusion, the goal of operative treatment is to restore stability and protect the knee against future meniscal or chondral lesions. Besides, the wish to return to pretrauma level and type of sport might be important considerations for operative treatment.

In case of nonoperative treatment, the majority of the respondents advocated adjusting the type of sports to avoid pivoting sports. Recent literature suggests that rehabilitation after ACL injury in children is mainly focused on neuromuscular stimulation and multijoint functional stability and less on muscular strength and hypertrophy. In the beginning, children should be guarded from performing pivoting activities and advised to wear a brace in sport. Although there are no solid studies on bracing children after ACL injury, a small majority advises to use a brace during sports participation. In this survey, the recommendations of the respondents adhere to the current limited scientific evidence for nonoperative treatment.

In case of operative treatment, most of the respondents perform a transphyseal repair. Different surgical techniques have been developed to address postoperative complications such as growth disturbances and graft failure. A recent systematic review of Pierce et al concluded that there is no difference in clinical outcome in regard to growth disturbances and re-rupture rate between transphyseal and physeal sparing procedures. Theoretical advantages of a transphyseal procedure are a more anatomical ACL reconstruction and more familiarity among surgeons compared with a physeal sparing procedure. One must note, however, that the results of the pooled data were weakened by lack of uniformity among the compared studies. To date, there is no convincing evidence to support a specific procedure for pediatric ACL reconstruction.

There is a variety in the duration of follow-up after ACL reconstruction among respondents in this survey. A third of the respondents did not respond to this item. The follow-up until skeletal maturity is performed by 27% of the respondents. Twenty-five percent of the respondents have a follow-up of less than 1 year postoperatively. These outcomes are similar to the findings in the ESSKA monitoring initiative survey. It is noticeable that most respondents do not follow the children until fully grown considering the risks of postoperative growth disturbances or graft failure.

The response rate of 29% (158/540) seems low. However, the NVA is an association of arthroscopy in general. Therefore, not only orthopaedic surgeons specialized in knee arthroscopy are member of this society, but the NVA has a great variation of members, such as orthopaedic surgeons (specialized in knee, shoulder, or any other joint), plastic surgeons, trauma surgeons, and veterinarians. This survey gives an overview of the opinion of the Dutch orthopaedic surgeons who perform ACL reconstructions in general (Table 1). Besides, the response rate is higher compared with a response rate of 22% in the ESSKA survey, but the total amount of respondents in ESSKA survey was 491. In contrast to the ESSKA survey, only the responses of orthopaedic surgeons were analyzed in this survey and the responses of trainees were excluded.

The questions in this survey are meant to evaluate the treatment of skeletally immature children in general. There is no further specification of the child besides the open joint.
phases. For example, one might consider using different surgical techniques based on the estimation of residual growth. Since these questions give an indication of the general treatment of children with open physes, a limitation is that these questions are not case specific and might therefore only give an indication of the techniques that are being used in the Netherlands.

Another limitation of this survey is that the use of patient-reported outcome measures (PROMs) is not evaluated. PROMs should be used to gain insight in the patient's perceived treatment results. In the ESSKA survey, all respondents used PROMs; however, only 15% used child-friendly questionnaires. In a recent systematic review, Dietvorst et al showed that the use of adults PROMs in children should be avoided. As the use of PROMs is not evaluated in this survey, no conclusion can be drawn about the use of these PROMs in the Netherlands.

Further research should aim at creating an evidence-based, skeletal, age-specific treatment algorithm. This requires high-level studies on nonoperative and operative treatments of pediatric ACL injuries. Different operative techniques should be evaluated and developed to minimize graft failure and growth disturbances. Determination of the duration and methods for follow-up must also be established. To evaluate future results of ACL reconstructions in children, there is a necessity for a registry to gain information on outcomes. Currently, a national registry for children with ACL injury is being developed.

In conclusion, this survey shows that the current state of care for pediatric ACL injuries is variable and a matter of debate in the Netherlands. Children with open physes tend to be treated nonoperatively, while children with closed physes are operated more frequently. In case of an operative treatment in a child with open physes, a transphyseal ACL reconstruction is most frequently performed. There is variation in the postoperative follow-up period. Further research should be aimed at creating an age-specific treatment algorithm and (inter) national guidelines should be developed. To gain information on future treatment results, a registry is being developed.

Note
This survey was conducted according to appropriate ethical standards.

Funding
No financial support was received for this study. This survey is an initiative of the NVA scientific committee.

Conflict of Interest
None declared.

References


25 Chen J, Ou L, Hollis SJ. A systematic review of the impact of routine collection of patient reported outcome measures on patients, providers and health organisations in an oncologic setting. BMC Health Serv Res 2013;13:211