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Review article

Incidence and risk factors for cyclops syndrome after anterior cruciate ligament reconstruction: A systematic literature review

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ABSTRACT

Background: Cyclops syndrome after anterior cruciate ligament (ACL) reconstruction is due to a fibrous nodule that develops in the anterior part of the intercondylar notch and prevents full knee extension. The primary objective of this systematic literature review was to evaluate the incidence of symptomatic cyclops lesion after ACL reconstruction. The secondary objective was to identify risk factors for cyclops syndrome.
Hypothesis: Cyclops syndrome is common after ACL reconstruction and has several risk factors reported in the literature.
Methods: A systematic literature review was performed by searching the PubMed, Medline, CINAHL, Cochrane, and Embase databases with the key terms 'cyclops' and 'ACL reconstruction'. The data thus retrieved were evaluated independently by two investigators. All articles in English or French that reported the incidence and risk factors of cyclops syndrome after ACL reconstruction were included.
Results: The search retrieved the titles and abstracts of 79 articles, of which 20 were selected to be read in full; among these, 10 were included in the study. The incidence of symptomatic cyclops lesion ranged from 1.9% to 10.9%. Identified risk factors were as follows: pre-operatively, knee inflammation and/or motion restriction at the time of ACL reconstruction; intra-operatively, narrow intercondylar notch and excessively anterior position of the tibial tunnel; and post-operatively, persistent hamstring muscle spasm.
Discussion: Development of a cyclops lesion is common after ACL reconstruction, occurs early, and may require further surgery. The knowledge of the risk factors provided by this study may improve the ability to devise effective preventive measures.
Level of evidence: II, systematic literature review.

1. Introduction

Reconstruction of the anterior cruciate ligament (ACL) is a commonly performed procedure that produces reliable and reproducible outcomes [1–3]. Although the post-operative complication rate is low, loss of knee extension may require revision surgery [4–7]. Cyclops syndrome was first described in 1990 by Jackson and Schaefer as loss of full knee extension due to the development of a fibrous nodule at the base of the ACL [8–10]. Early impingement of the nodule on the roof of the intercondylar notch limits knee extension [9]. Repeated microtrauma perpetuates the fibrotic process responsible for nodule formation, resulting in painful extension loss [9–11]. Early revision surgery is required to prevent the development of degenerative lesions in the short term [12,13]. Cyclops syndrome has been reported in patients who did not undergo ACL reconstruction [10,14,15]. Fibrous tissue at the tibial attachment of the reconstructed ACL is often visible by magnetic resonance imaging (MRI) but is not associated with clinical symptoms [16,17].

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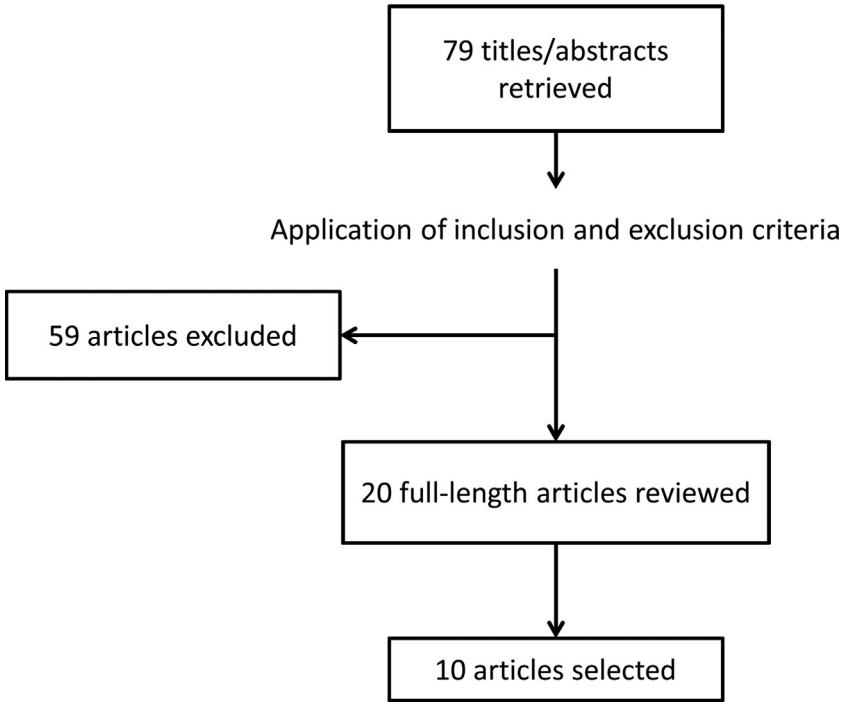

Fig. 1. PRISMA flow diagram.

The diagnosis of cyclops syndrome rests on the post-operative clinical and MRI findings [18,19]. Early revision surgery is effective in restoring motion range in the absence of osteoarthritis [12].

The primary objective of this systematic literature review was to evaluate the incidence of symptomatic cyclops lesion after ACL reconstruction. The secondary objective was to identify risk factors for cyclops syndrome. The working hypothesis was that cyclops syndrome is common after ACL reconstruction and has several risk factors reported in the literature.

2. Material and Methods

The study followed recommendations for systematic literature reviews and meta-analyses [20,21]. The study objectives, methodology, and criteria for including and excluding articles were determined before data collection. The PubMed, Medline, CINAHL, Cochrane, and Embase databases were searched in July and August 2018 using two MeSH indexing terms, 'cyclops' and 'ACL reconstruction'. As cyclops syndrome was first described in 1990 [7], no major studies on the topic were published before this date. Consequently, indexing terms such as 'arthrofibrosis' and 'stiffness' did not retrieve additional articles.

Articles were included if they supplied information on the incidence and risk factors of cyclops syndrome after ACL reconstruction. Information was recorded on the diagnostic tools used to determine the incidence of cyclops syndrome (e.g., physical examination, imaging studies, arthroscopy, or several tools combined). The other inclusion criteria were as follows: article in English or French, abstract available online, patients aged 18 years or older, autograft or allograft ACL reconstruction, and clinical trial or cohort study. No time limits were applied. Studies were excluded if they involved patients with injuries to multiple ligaments or concomitant bone lesions, more than one ACL reconstruction procedure, or procedures on the bone in addition to the ACL reconstruction. In addition, cadaver studies and case reports were excluded.

Two of us (TN and AH), working independently of each other, selected articles based on the titles and abstracts. Disagreements were resolved by consensus. After an extensive review of the articles, a second selection procedure was applied to ensure that no major articles had been missed. The following data were extracted from each selected article: demographics, incidence of cyclops syndrome, risk factors for cyclops syndrome, time to symptom onset, and level of evidence.

The methodological quality of the articles was assessed by the same two investigators (TN, AH), who independently applied the Cochrane risk-of-bias tool based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA [20]) statement. Heterogeneity was evaluated qualitatively by comparing study designs, study populations, types of ACL reconstruction, outcomes, and blinding. Homogeneity testing was not performed.

3. Results

3.1. Article selection

Of the 79 initially retrieved articles (Fig. 1), 20 were selected based on the title and abstract. Of these, 9 were included in the study, together with an additional study identified by manually checking the reference lists of selected articles. Table 1 lists the 10 included articles. Publication dates ranged from 1995 to 2017. There was no overlap in study populations. The level of evidence was II for two articles, III for two articles, and IV for six articles. The diagnosis of cyclops syndrome was established by arthroscopy only in 3 studies, physical examination only in 3 studies, imaging studies only in 1 study, physical examination and arthroscopy combined in 2 studies, and physical examination and imaging studies combined in 1 study.

The results of the study quality assessment according to PRISMA are reported in the electronic appendix.

3.2. Incidence

The incidence of symptomatic cyclops syndrome ranged from 1.9% to 10.2% after single-bundle reconstruction [18,21–23] and

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Table 1
Selected studies and incidence of cyclops syndrome diagnosed by physical examination, arthroscopy, and/or magnetic resonance imaging.

Authors	Year of publication	Study design	Primary objective	Patients, *n*	Follow-up (months)	Level of evidence	Incidence of cyclops syndrome		
							Clinical	Arthroscopic	MRI
Delincé [26]	1998	Descriptive	Characteristics of the lesions	65	14-35	IV	-	35.4%	-
Muellner [30]	1999	Prospective	Outcomes of ACL reconstruction	119	5.9-9.5	II	-	17.6%	-
Ahn [5]	2007	Retrospective	Identification of good prognostic factors	208	21.2	IV	-	21.5%	-
Wang [17]	2009	Therapeutic case series	Histological study	311	13.3	IV	1.9%	14.5%	-
Sonnery-Cottet [24]	2010	Therapeutic case series	Characteristics of double-bundle ACL reconstruction	387	12	IV	3.6%	-	-
Gohil [18]	2014	RCT	Clinical and MRI evaluation of the lesions	48	12	II	10.2%	-	46.8%
Fujii [25]	2015	Case-control	Lesions and intercondylar notch size	55	45.6	IV	10.9%	27.3%	-
Pinto [28]	2017	Case-control	Cyclops syndrome and hamstring spasm	45	6	III	2.1%	-	-
Sanders [22]	2017	Historical cohort	Incidence, risk factors, and outcomes	1841	123.6	III	2%	-	-
Facchetti [8]	2017	Descriptive	MRI findings	113	24	IV	-	-	33% (after 2 years)

ACL: anterior cruciate ligament; MRI: magnetic resonance imaging; RCT: randomised controlled trial.

from 3.6% to 10.9% after double-bundle reconstruction [24,25]. The incidence of cyclops lesions visible arthroscopically as a fibrous nodule in the intercondylar notch ranged from 15.0% to 35.0% [5,24,26] and the incidence of cyclops lesions seen by MRI from 33.0% to 46.8% [8,18].

3.3. Risk factors

3.3.1. Intrinsic risk factors

A 2.6-fold increase in the risk of cyclops syndrome in young females was found in two studies [22,25]. In contrast, another study found no risk increase in young females but noted a higher risk of radiological cyclops lesions in patients with low body mass index values ($P = 0.002$) [8]. The rate of surgical revision to treat cyclops syndrome was 6.3% in patients whose ACL reconstruction was performed within 48 h after the injury compared to 2.5% when the procedure was done after resolution of the inflammatory response; however, this difference was not statistically significant [27].

No associations with the development of cyclops syndrome were found for age [7,22,25,28], level of sports activities [28], or presence of bone bruising [28].

3.3.2. Surgical factors

The risk of cyclops syndrome was 5.3 times higher after surgical ACL reconstruction than after non-operative treatment [22]. Among intra-operative factors, a narrow intercondylar notch was associated with a higher risk of cyclops syndrome ($P = 0.01$) [25]. Watanabe et al. [29] suggested that anterior positioning of the tibial tunnel might increase the risk, but this possibility was not supported by studies by Fujii et al. [25] and Muellner et al. [30]. When double-bundle reconstruction was performed, the use of a quadricipital tendon autograft was associated with a higher risk compared to the risk of a hamstring tendon autograft [24]. None of the studies compared the incidence of cyclops syndrome between patients managed by single-bundle versus double-bundle reconstruction.

Sanders et al. reported a 6.7-fold increase in the risk of cyclops syndrome when the ACL reconstruction was performed more than 4 weeks after the injury [22]. Others, however, did not replicate this finding [17,28].

The following factors were not associated with the occurrence of cyclops syndrome: arthroscopy or open surgery for the ACL reconstruction [26], use of patellar tendon or hamstring tendon grafts [5,17,22,28], preservation of the residual ACL fibres [18], concomitant meniscal repair [22,25], or concomitant antero-lateral reconstruction [28].

3.3.3. Post-operative factors

During the immediate post-operative period, loss of active knee extension and stunning of the quadriceps were associated with a higher risk of cyclops syndrome [24]. Pinto et al. reported that hamstring spasm 3 to 6 weeks after surgery was a risk factor for cyclops syndrome: hamstring spasm was present in 58% of the 45 patients who required revision surgery for cyclops syndrome compared to only 24% of the controls ($P < 0.001$) [28]. The time from surgery to the initiation of post-operative rehabilitation was not associated with the risk of cyclops syndrome [17,25].

4. Discussion

The incidence of symptomatic cyclops lesion after ACL reconstruction ranged from 1.9% to 10.9% and remained stable over time (Table 1). This systematic literature review helped to identify several specific risk factors including knee inflammation and knee stiffness before surgery, a narrow intercondylar notch and excessively anterior tibial tunnel position, and hamstring spasm after surgery. Knowledge of these risk factors may help to decrease the risk of cyclops syndrome [31].

Factors that were not associated with the occurrence of cyclops syndrome included age [22,28], level of sports activities [28], bone bruising [28], use of arthroscopy or open surgery [26], use of patellar or hamstring graft material [5,17,22,28], preservation of residual ACL fibres [18], concomitant meniscal repair [22,25], concomitant antero-lateral ligament reconstruction [28], and time from surgery to the initiation of rehabilitation therapy [17,25].

The best treatment of cyclops syndrome is the institution of preventive measures that decrease the incidence and impact of the condition. When revision surgery to perform anterior release is required, the range-of-motion outcomes are disappointing [32]. Revision surgery must be performed within 1 year after ACL reconstruction and must be followed by an appropriate rehabilitation programme [11,33].

Among pre-operative factors, the time from injury to surgery does not seem associated with the risk of cyclops syndrome [8]. In contrast, knee inflammation (oedema, effusion) and knee stiffness are risk factors [12,34].

During surgery, preventive measures include anatomical graft positioning, evaluation for anterior dislocation of the ACL stump that might be overlooked, notch reconstruction if needed, the use of gradually increasing drill bit diameters to create the tunnels, and routine removal of bone and cartilage fragments, notably at the tibial ACL insertion [26].

Proximally, hypertrophic scarring of the synovial membrane or ligament suspending the Hoffa fat pad to the roof of the notch should be sought by arthroscopic inspection at the end of the procedure, with the knee extended. Inverted cyclops lesions have been described and require careful attention to the roof of the notch during surgery [35,36]. A narrow notch and excessively anterior position of the tibial tunnel were also identified as risk factors [25,37]. The risk was not associated with the type of graft material (patellar vs. hamstring tendons) or preservation of the residual ACL fibres [17,38–41].

After surgery, hamstring spasm and stunning of the quadriceps were associated with a higher risk of cyclops syndrome [24,28].

One of the limitations of this study is the low level of evidence provided by the selected articles. Furthermore, cyclops syndrome is defined as loss of knee extension combined with imaging study evidence of a fibrous nodule in the intercondylar notch [8,18]. Sole reliance on arthroscopy tends to overestimate the incidence of cyclops syndrome, and MRI has a high false-positive rate [16,17].

5. Conclusion

The incidence of symptomatic cyclops syndrome ranged from 1.9% to 10.9%. The following risk factors were identified: before surgery, knee inflammation and knee motion range restriction at the time of surgery; during surgery, a narrow intercondylar notch and excessively anterior tibial tunnel; and after surgery, persistent hamstring spasm. Knowledge of these risk factors allows the development of preventive measures.

Disclosure of interest

The authors declare that they have no competing interest.

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Authors' contributions

TN and AH selected the articles.
All authors contributed to create and validate the manuscript.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.otsr.2019.07.007.

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