



# Risk Factors for Symptomatic Cyclops Lesion Formation after Anterior Cruciate Ligament Reconstruction

## *Fatores de risco para formação de lesão cyclops sintomática após a reconstrução do ligamento cruzado anterior*

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### Abstract

**Objective** To evaluate the incidence of symptomatic cyclops lesions requiring surgical treatment after anterior cruciate ligament (ACL) reconstruction and to establish possible intraoperative risk factors related to it.

**Methods** Three hundred and eighty-nine patients aged between 18 and 50 years who underwent primary ACL reconstruction were retrospectively evaluated. Patients were divided into groups according to the presence or absence of symptomatic cyclops lesions, and their characteristics were compared. Patients with associated lesions that required additional surgical procedures (except anterolateral extra-articular procedures) were not included. The rate of symptomatic cyclops lesions was recorded and the following parameters were evaluated: age, gender, time from injury to surgery, graft type and diameter, femoral tunnel perforation technique, fixation type, presence of knee hyperextension, preservation of the ACL remnant, associated anterolateral extra-articular procedure, associated meniscal injury and participation in sports.

**Results** 389 patients were evaluated and 26 (6.7%) patients developed cyclops. The patients with and without cyclops lesions did not differ in age, time from injury to surgery, graft type or diameter, surgical technique, femoral fixation method, presence

### Keywords

- ▶ anterior cruciate ligament
- ▶ cyclops
- ▶ knee joint
- ▶ ligaments, articular
- ▶ range of motion, articular

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of knee hyperextension, remnant preservation and associated meniscal injury. The group with cyclops lesion had a higher proportion of females (10 (38.4%) vs 68 (18.7%); OR = 2.7;  $p = 0.015$ ), higher proportion of extra-articular reconstruction (18 (11.8%) vs 8 (3.4%); OR = 3.8;  $p = 0.001$ ) and higher proportion of sports practice (23 (8.6%) vs 3 (2.5%); OR = 3.6;  $p = 0.026$ ).

**Conclusion** In our series, 6.7% of the patients required arthroscopic removal of cyclops lesions. Female gender, associated extra-articular reconstruction and sports practice were factors related to this lesion. Remnant preservation had no relationship with cyclops lesion formation.

## Resumo

**Objetivo** Avaliar a incidência de lesões *cyclops* sintomáticas que precisam de tratamento cirúrgico após a reconstrução do ligamento cruzado anterior (LCA) e estabelecer os possíveis fatores de risco intraoperatórios relacionados a elas.

**Métodos** Trezentos e oitenta e nove pacientes com idades entre 18 e 50 anos submetidos à reconstrução primária do LCA foram avaliados de forma retrospectiva. Os pacientes foram divididos em grupos de acordo com a presença ou ausência de lesões *cyclops* sintomáticas e suas características foram comparadas. Não foram incluídos pacientes com lesões associadas que necessitassem de outros procedimentos cirúrgicos (à exceção de procedimentos extra-articulares ântero-laterais). A taxa de lesões *cyclops* sintomáticas foi registrada e os seguintes parâmetros foram avaliados: idade, sexo, tempo da lesão à cirurgia, tipo e diâmetro do enxerto, técnica de perfuração do túnel femoral, tipo de fixação, presença de hiperextensão do joelho, preservação do LCA remanescente, associação a procedimento extra-articular ântero-lateral, lesão de menisco associada e participação em esportes.

**Resultados** Dos 389 pacientes avaliados, 26 (6,7%) desenvolveram lesão *cyclops*. Os pacientes com e sem lesão *cyclops* não diferiram quanto à idade, tempo da lesão à cirurgia, tipo ou diâmetro do enxerto, técnica cirúrgica, método de fixação femoral, presença de hiperextensão do joelho, preservação do LCA remanescente e lesão de menisco associada. O grupo com lesão *cyclops* apresentou mais mulheres (10 [38,4%] vs. 68 [18,7%]; razão de probabilidades [OR] = 2,7;  $p = 0,015$ ), maior proporção de reconstrução extra-articular (18 [11,8%] vs. 8 [3,4 %]; OR = 3,8;  $p = 0,001$ ) e maior proporção de prática esportiva (23 [8,6%] vs. 3 [2,5%]; OR = 3,6;  $p = 0,026$ ).

**Conclusão** Em nossa série, 6,7% dos pacientes necessitaram de remoção artroscópica das lesões *cyclops*. O sexo feminino, a reconstrução extra-articular associada e a prática esportiva foram fatores relacionados a essa lesão. A preservação do menisco remanescente não foi associada à formação de lesões *cyclops*.

## Palavras-chave

- ▶ amplitude de movimento articular
- ▶ articulação do joelho
- ▶ cyclops
- ▶ ligamento cruzado anterior
- ▶ ligamentos articulares

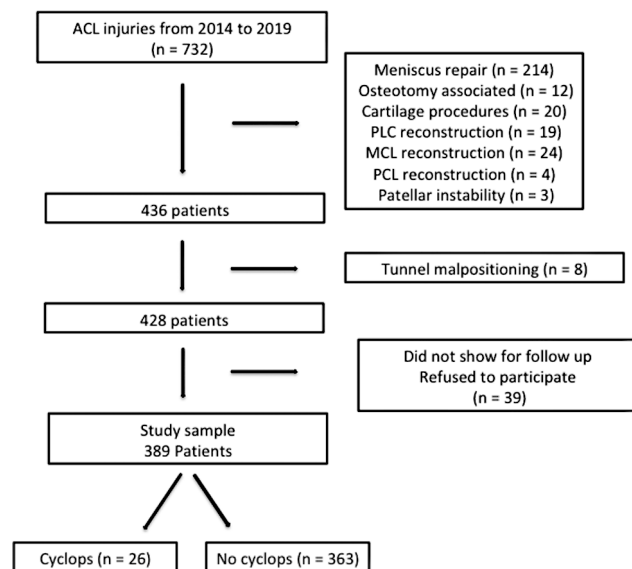
## Introduction

Anterior cruciate ligament (ACL) injuries are very common among sport practitioners.<sup>1</sup> In most cases, the indicated treatment is the reconstruction of this structure, although modern repair techniques and even conservative treatment can be employed in special situations.<sup>2,3</sup> Several techniques and graft types can be used for reconstruction procedures, with risks and benefits, as well as possible complications and need to reoperations, inherent to each technique.<sup>4</sup> Symptomatic cyclops lesions are one reason for reoperation after an ACL reconstruction.<sup>5,6</sup>

A cyclops lesion is a fibrous nodule formation anterior to the reconstructed ACL graft that may or may not be symptomatic.<sup>7</sup> A study by Facchetti et al.<sup>7</sup> using imaging exams

showed that although cyclops lesions were present in up to 25% of patients at 6 months of follow-up, most lesions did not cause functional impairment. In symptomatic cases, the most common symptoms are anterior knee pain, joint effusion and final knee extension loss.<sup>8</sup> Surgery to treat this lesion may be necessary in 1 to 10% of patients after ACL reconstruction.<sup>9,10</sup>

Recent studies have found possible risk factors for this nodular formation, such as extension loss at the time of ACL reconstruction or during the initial postoperative period due to quadriceps inhibition, a narrow intercondylar notch or tibial tunnel malpositioning.<sup>9,11,12</sup> The role of other intraoperative variables, such as preservation of the remnant of the original injured ligament, different grafts or techniques and associated extra-articular reconstruction, are controversial according to



**Fig. 1** Flow chart of the study.

the literature.<sup>11</sup> Associated procedures, such as meniscal repairs, are also possible confounding variables because they can lead to changes in rehabilitation.<sup>13</sup>

The objective of the present study is to evaluate the incidence of symptomatic cyclops lesions requiring surgery and to establish possible intraoperative risk factors, excluding occasional technical errors or associated procedures, that lead to changes in rehabilitation. We hypothesize that no risk factor will be associated with this lesion, including remnant preservation.

## Materials and Methods

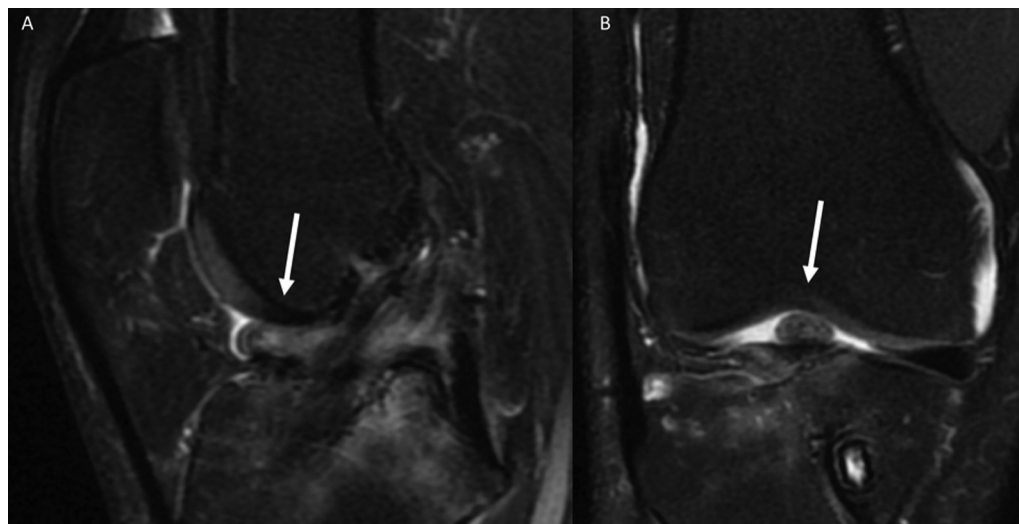
The study was approved by the ethics committee of our institution, and informed consent was obtained. Three hundred and eighty-nine patients aged between 18 and 50 years

who underwent primary ACL reconstruction between January 2014 and January 2019 were retrospectively evaluated, although data collection was prospectively performed. Patients with associated lesions that required additional surgical procedures, such as osteotomies and the reconstruction of other ligaments (except extra-articular anterolateral ligament (ALL) reconstruction or iliotibial tract tenodesis associated with the ACL that did not interfere with postoperative rehabilitation) and those who underwent treatment for cartilage injuries or meniscal repairs were not included as these procedures could affect postoperative rehabilitation and follow-up. Only patients who had full range of motion during the preoperative period underwent reconstruction. During the immediate postoperative period, the patients underwent frontal and lateral radiography, and cases in which the tibial tunnel was malpositioned were excluded (►Fig. 1).

Symptomatic cyclops lesions were defined as the presence of anterior knee pain and confirmed final extension loss with the visualization of nodulation on magnetic resonance imaging and subsequent arthroscopy (►Fig. 2). Patients with clinical symptomatology without nodulation or fibrosis in the region anterior to the ACL were not considered to have cyclops lesions. Patients were divided into groups according to the presence or absence of symptomatic cyclops lesions, and their characteristics were compared.

The following parameters were evaluated: age, gender, time from injury to surgery, graft type used and graft diameter, femoral tunnel perforation technique (transportal or outside-in), fixation type used for the femur and tibia, presence of knee hyperextension (defined as hyperextension greater than 5 degrees), preservation of the ACL remnant in the tibia at the time of surgery, associated anterolateral extra-articular procedure (iliotibial tract tenodesis or ALL reconstruction), associated meniscal injury and participation in sports activity.

In the patients who underwent remnant preservation, the ACL graft was passed through the inside and not through the



**Fig. 2** Magnetic resonance imaging of a right knee after anterior cruciate ligament reconstruction showing a cyclops lesion (indicated by the arrow).

side of the tibial remnant so that the remnant fibers functioned as a scaffold, and the fibers of the ACL remnant of the femur were detached to prepare the femoral tunnel.<sup>14</sup> Selective single-bundle reconstructions (anteromedial or posterolateral) were not performed in this series. After the guide wire was passed through the tibia, a drill was used at low rotation to avoid damaging the fibers of the remnant. Abundant cleaning was performed with the shaver blade inside the remnant to avoid the accumulation of debris originating from the tibial tunnel.<sup>7</sup>

All patients followed the same rehabilitation protocol without postoperative immobilization. Partial weight-bearing with two crutches was allowed starting on the first postoperative day, with progression to full weight-bearing as tolerated. Range of motion exercises were also stimulated starting on the first postoperative day.

## Statistical Analysis

Numerical variables are described as mean and standard deviation, and categorical variables are described as absolute numbers and percentages within the group. Numerical variables were compared between groups using the Mann-Whitney U test. For categorical variables, Fisher's exact test or the chi-square test was used in the respective contingency tables, and odds ratios (OR) were calculated.

## Results

Twenty-six (6.7%) patients developed cyclops lesion. The patients with and without cyclops lesions did not differ in age, time from injury to surgery, graft type or diameter used for ACL reconstruction, surgical technique used to create the

femoral tunnel, femoral fixation method, presence of knee hyperextension, remnant preservation and associated meniscal injury (→ **Table 1**). All patients underwent tibial fixation with interference screws, so it was not possible to perform a statistical analysis of this variable.

The group with cyclops lesion had a higher proportion of female patients (10 (38.4%) vs 68 (18.7%); OR = 2.7;  $p = 0.015$ ). Eighteen (11.8%) patients who underwent associated extra-articular reconstruction developed a cyclops lesion, compared with only 8 (3.4%) patients who underwent intra-articular reconstruction alone (OR = 3.8;  $p = 0.001$ ). Sports practice was also related to the presence of symptomatic cyclops lesion, and 23 (8.6%) patients who developed cyclops lesion practised some sport, compared with only 3 (2.5%) who did not practice any sport (OR = 3.6;  $p = 0.026$ ).

## Discussion

The main finding of this study is that, after ACL reconstruction, the factors related to an increased likelihood of the formation of symptomatic cyclops lesion requiring resection are female gender, associated extra-articular reconstruction and sports practice. Preservation of the tibial ACL remnant was not a risk factor for this type of lesion. This finding contradicts our initial hypothesis that no risk factor would be significantly associated with the occurrence of this type of lesion.

Noailles et al.<sup>11</sup> performed a systematic review of the incidence of and risk factors for cyclops lesions after ACL reconstruction. These authors identified an increased risk of cyclops lesion related to preoperative factors, such as knee inflammation and range of motion restriction; intra-operative factors, such as a narrow intercondylar notch

**Table 1** Characteristics of the groups

	Cyclops lesion (n = 26)	No cyclops lesion (n = 363)	p
Age (years)	29.2 ± 9.2	29.6 ± 7.9	0.700
Female sex	10 (38.4%)	68 (18.7%)	0.022
Time since injury (months)	7.2 ± 6.5	6.9 ± 12.6	0.564
Type of graft	Hamstrings 24 (92.3%) BTB 29 (7.7%)	Hamstrings 329 (90.6%) BTB 29 (8.0%) Quadriceps tendon 3 (0.8%) Allograft 2 (0.5%)	1.0
Graft diameter (mm)	8.1 ± 0.6	8.3 ± 0.7	0.208
Femoral tunnel perforation technique	Outside-in 21 (80.8%) Medial portal 5 (19.2%)	Outside-in 263 (72.5%) Medial portal 100 (27.5%)	0.379
Femoral fixation method	Interference screw 21 (80.7%) Endobutton 5 (19.3%)	Interference screw 239 (65.8%) Endobutton 115 (31.7%) Other 9 (2.5%)	0.312
Presence of knee hyperextension	6 (23.0%)	124 (34.1%)	0.247
Remnant preservation	10 (38.4%)	137 (37.7%)	0.942
Associated extra-articular reconstruction	18 (69.2%)	134 (36.9%)	0.001
Associated meniscal injury	4 (15.3%)	78 (21.4%)	0.461
Sports practice	23 (88.4%)	245 (67.4%)	0.026

and anterior malpositioning of the tibial tunnel; and postoperative factors, such as persistent hamstring spasm. Another recent review by Kambhampati et al.<sup>10</sup> found female sex, greater graft volume, bony avulsion injuries, excessively anterior tibial tunnel and double bundle reconstructions as risk factors. In the present study, some of these confounding factors related to cyclops formation were not analyzed because all patients underwent surgery only after achieving full range of motion, and patients with malpositioned tibial tunnels were excluded. Regarding extra-articular reconstructions, of the 10 studies included in the review performed by Noailles et al.,<sup>11</sup> only the one by Pinto et al.<sup>15</sup> included this variable. However, unlike the present study, that study did not find a relationship between this variable and an increased risk of cyclops lesion. Kambhampati et al. did not mention extra-articular procedures in their review.

We believe that we found a correlation between extra-articular reconstruction and cyclops lesion formation because these patients may eventually present increased postoperative pain, especially in cases of iliotibial tract tenodesis, which can cause increased quadriceps inhibition and favors hamstrings contracture and consequently knee flexion, which in turn creates conditions that favor the formation of cyclops lesion in the space between the ACL graft and the intercondylar notch.<sup>12</sup> Delaloye et al.,<sup>12</sup> in turn, showed in a series of 3,633 patients that the only risk factor associated with cyclops lesion was an extension deficit during the initial postoperative period, suggesting that this lack of extension could be caused by arthrogenic muscle inhibition.<sup>16</sup> Thauinat et al.,<sup>6</sup> in a recent series that evaluated the reoperation rate after combined intra- and extra-articular reconstruction, also did not find a greater number of complications in cases in which associated anterolateral procedures were performed. Thus, our finding that a higher risk of cyclops lesions was related to extra-articular procedures is unprecedented and contradictory with the literature on extra-articular reconstructions, as this complication was not frequently reported in any of the existing studies of extra-articular reconstruction.<sup>17-22</sup> We believe that this finding deserves to be studied in more detail in future series and should not currently be a factor for non-indication or changed indication for extra-articular procedures combined with ACL reconstruction.

There is no consensus regarding whether female gender is a risk factor for cyclops lesion formation. Our study, as well as those of Sanders et al.<sup>23</sup> and Fujii et al.,<sup>9</sup> found a relationship between female gender and cyclops lesion formation, unlike Facchetti et al.<sup>7</sup> Possible reasons for the higher risk in women are reduced quadriceps strength, greater difficulty achieving extension and increased pain. It is important to advise female patients about this possibility during preoperative evaluation, especially in cases of major quadriceps strength deficit during the preoperative period.

Sports practice was also characterized as a risk factor for the formation of cyclops lesions. According to previous studies, most cyclops lesions are asymptomatic, and we believe that patients who play sports have a greater chance of perceiving symptoms in an existing injury due to the

greater functional demands placed on the knee.<sup>7</sup> We could not identify other factors that may be related to sports and the formation of this lesion, and the possibility that this could be a random finding cannot be discarded. Pinto et al.<sup>15</sup> found no association between professional athletes and cyclops lesion formation.

There is concern that the preservation of the ACL remnant may be a risk factor for cyclops lesions because the remnant occupies more space in the intercondylar area when combined with the reconstructed ligament graft.<sup>24-26</sup> We believe that remnant preservation and the construction of the new ACL within this scaffold does not lead to an exaggerated increase in volume in the intercondylar area and, therefore, does not favor cyclops lesion formation.<sup>14,27</sup> Our study did not find this association, nor did recent studies that used the same preservation technique.

A potentially important factor that could not be quantitatively assessed in the present study is the debridement from the tibial tunnel. We believe that using the shaver for proper cleaning of the tibial tunnel is of utmost importance and that no debris should be left between the graft and the remnant, and this approach was routinely performed in our reconstructions in an empirical manner. Iman et al.<sup>28</sup> showed that there may be bone debris in up to 69% of patients after ACL reconstruction, and Nagira et al.<sup>8</sup> showed that debridement can reduce cyclops lesions. We believe that in cases of remnant preservation, debris originating from the tibial tunnel may be left as it is difficult to visualize this bone debris because of the native ACL tissue covering the entrance to the tunnel, and this debris may help the formation of cyclops lesions.

The limitations of the present study include its retrospective nature, although the data were collected prospectively. Unfortunately, we did not assess postoperative pain in our study. Theoretically better pain control at the time of surgery and afterward, combined with preoperative quadriceps activation training, could possibly prevent or at least reduce loss of extension. This drawback may have been a confounding factor in the finding of extra-articular reconstruction as a risk factor for cyclops lesion. Potentially relevant factors, such as the presence of postoperative flexion and muscle activation, were also not measured, although all treated patients had full range of motion and activated quadriceps at the time of surgery. This factor should be considered in future analyses. The presence of few cases of reconstruction with tissue-bank tendons, reconstruction with quadriceps tendon and other methods of femoral fixation in addition to the endobutton and interference screw can also be considered limitations because they reduce the statistical power for evaluating these variables.

## Conclusion

In our series, 6.7% of the patients required arthroscopic removal of cyclops lesions. Female gender, associated extra-articular reconstruction and sports practice were factors related to the presence of this lesion. Remnant preservation had no relationship with cyclops lesion formation.

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**Conflict of Interest**

The authors report no conflict of interest in relation to this study.

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