Original article

Correlation between Ahlbäck radiographic classification and anterior cruciate ligament status in primary knee arthrosis[☆]

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ABSTRACT

Objective: To correlate the Ahlbäck radiographic classification with the anterior cruciate ligament (ACL) status in knee arthritis patients.

Methods: The study evaluated 89 knees of patients who underwent total knee arthroplasty due to primary osteoarthritis: 16 male and 69 females, with mean age 69.79 years (53–87 years). Osteoarthritis was classified radiographically by the Ahlbäck radiographic classification into five grades. The ACL was classified in the surgery as present or absent. The correlation of ACL status and Ahlbäck classification was assessed, as well as those of ACL status and the parameters age, gender, and tibiofemoral angulation (varus–valgus).

Results: In cases of varus knees, there was a correlation between grades I to III and ACL presence in 41/47 (86.7%) cases and between grades IV and V and ACL absence in 15/17 (88.2%) cases ($p < 0.0001$). In valgus knees, no statistically significant correlation was observed between the ACL status and the Ahlbäck classification. In the present study, absence of the ACL was more common in men (9/17; 52%) than in women (19/72; 26%).

Conclusion: In cases of medial osteoarthritis, the Ahlbäck radiographic classification is a useful parameter to predict ACL status (presence or absence). In gonarthritis in genu valgum, ACL status was not predicted by Ahlbäck's classification.

Correlação entre a classificação radiográfica de Ahlbäck e o estado de conservação do ligamento cruzado anterior em gonartrose primária

R E S U M O

Palavras-chave:
Ligamento cruzado anterior
Artrose do joelho
Artroplastia do joelho

Objetivo: Correlacionar a classificação radiográfica de Alhbäck com o estado de conservação do ligamento cruzado anterior (LCA).

Métodos: Avaliados 85 pacientes (89 joelhos) submetidos à artroplastia total de joelho por osteoartrose primária. Foram 16 homens e 69 mulheres com média de 69,79 anos (53 a 87). A osteoartrose foi subdividida em cinco graus de acordo com a classificação radiográfica de Alhbäck. O LCA foi avaliado na cirurgia como presente ou ausente. Foi feita a correlação entre o estado do LCA e a classificação de Ahlbäck. Foi também analisada a correlação entre o estado do LCA e os parâmetros idade, sexo, angulação tibiofemoral (varo-valgo).

Resultados: Nos casos de joelho varo, foi observada uma correlação entre os graus I até III e a presença do LCA em 41/47 (86,7%) casos, bem como entre a ausência do LCA e os graus IV e V em 15/17 (88,2%) casos (p < 0,0001). Por outro lado, nos casos de joelho valgo não houve relação estatisticamente significante entre a presença ou ausência do LCA e a classificação de Alhbäck. Nesta série, foi observado que a ausência do LCA foi mais comum entre os homens 9/17 (52%) do que em mulheres 19/72 (26%).

Conclusões: Nos casos de gonartrose do compartimento medial, a classificação de Alhbäck é parâmetro confiável para prever a condição do LCA (presente ou ausente). Nos casos de gonartrose em genu valgo não se observou correlação entre a classificação de Alhbäck e a condição do LCA.

Introduction

The Ahlbäck radiographic classification for knee osteoarthritis was originally described by the author[1] in 1968 and modified in 1992 by Keyes et al.,[2] who subdivided it into five grades (I–V). This classification is the most commonly used by orthopedic surgeons, not only to assess the degree of radiographic involvement, but also to monitor disease progression and assist in surgical planning.

Despite the widespread use of this classification, some studies criticize the inadequate levels of interobserver agreement with different degrees of experience. However, this classification is more reproducible when used by experienced observers.[3,4]

One of the factors to be taken into account before a surgical procedure in the treatment of knee arthrosis is the preservation status of the anterior cruciate ligament (ACL). Keyes et al.,[2] in their work, recommended osteotomy or unicompartmental prosthesis for cases with intact ACL. When the ACL is compromised, total knee arthroplasty would be indicated.

In this classic study,[2] although the authors analyzed 200 cases of medial arthrosis of the knee, in only 25% of the cases (50 knees) was the presence or absence of the ACL evaluated and described. No other studies evaluating the same correlation were retrieved in the literature. This raises the question of what the relationship between ACL preservation status and Ahlbäck classification would effectively be.

The possibility of determining the ACL preservation status preoperatively through a radiographic examination of the knee based on Alhbäck classification would be relevant in choosing the most appropriate surgical technique[2] for cases of knee arthrosis. This information becomes more significant when considering the increasing trend to use implants that aim to preserve the still intact structures in cases of knee arthrosis. Examples of this trend include the use of unicompartmental prosthesis[5] and prostheses that allow preservation of both cruciate ligaments, currently under evaluation.[6,7]

The present study aimed to correlate the Ahlbäck radiographic arthrosis classification with the ACL preservation status (absent/present).

The secondary goal was to correlate the ACL preservation status with the parameters age, gender, and tibiofemoral angle (varus/valgus).

Material and methods

This study was approved by the Research Ethics Committee of this hospital and follows the Helsinki Convention norms.

Eighty five (89 knees) consecutive patients who underwent total knee arthroplasty with substitution of the posterior cruciate ligament between November 2010 and November 2014 were studied. Of the 85 patients, 16 were male and 69 female; their age ranged from 53 to 87 years (mean 69.79).

Only cases of primary arthrosis in individuals over 50 years were included. Patients who had undergone previous knee osteosynthesis surgery, osteotomies, and arthrotomies were not included, as well as cases of osteonecrosis, rheumatologic disease, or post-traumatic sequelae.

Standard digital weight bearing radiographs of the knee were made including the shafts of the distal femur and

Grade	Anteroposterior radiography	Profile radiography
I	Joint space narrowing	–
II	Joint space obliteration	–
III	Bone contact smaller than 5 mm	Normal posterior region
IV	Bone contact between 5 and 10 mm	Posterior osteophytes
V	Severe subluxation	Anterior subluxation of the tibia greater than 10 mm

Table 1 – Ahlbäck radiological classification.

proximal tibia. A goniometer was used to measure the tibiofemoral angle, which is formed by the intersection of the femoral and tibial anatomical axes, as described by Kraus et al.[8] and Hinman et al.[9] When the tibiofemoral axis was diverted to the medial compartment, the knee was considered to be in varus. When it was on the lateral compartment, the knee was considered to be in valgus. In 25 (28%) cases, the knee was described as valgus, and in 64 (72%), as varus.

Patients with varus knee were divided into two subgroups: varus equal to or above 10°, and varus below 10°. Patients with valgus knee were divided into two subgroups: valgus equal to or above 15°, and valgus below 15°.

The abovementioned radiographs were classified into five grades of arthrosis using the Ahlbäck[1] classification (1968) modified by Keyes et al.[2] (Table 1).

Two specialist surgeons with over 15 years experience in arthroplasty analyzed the radiographic parameters (Ahlbäck classification and tibiofemoral angle). The two evaluators analyzed the X-rays simultaneously, working together. In case of disagreement, a third colleague with equal experience helped determining the final result. During the process of radiographic analysis, the evaluators did not have access to the identification or data of patients. The Ahlbäck classification was available for consultation by the evaluators throughout the process of radiographs analysis.

Fig. 1 – Present ACL, shown on the surgical clamp.

Table 2 – Correlation between the ACL preservation status and clinical-radiographic parameters.

Variable	ACL preservation status		Statistical analysis
	Absent	Present	
Gender			
Male	9 (52%)	8 (48%)	$p = 0.044$
Female	19 (26%)	53 (74%)	
Age	70.1 + 6.7	69.6 = −7.9	$p = 0.38$
TF Ang			
Varus	21 (35.5%)	38 (64.5%)	$p = 0.274$
Valgus	7 (28%)	18 (72%)	
Varus			
<=10	16 (29.6%)	38 (69.4%)	$p = 0.275$
>10°	5 (50%)	5 (50%)	
Valgus			
<15°	2 (15.4%)	11 (84.6%)	$p = 0.202$
≥15	5 (41.6%)	7 (58.4%)	

TF Ang, tibiofemoral angle; ACL, anterior cruciate ligament.

During surgery, the state of ACL preservation was assessed by the lead author. Only the presence or absence of the ligament was recorded (Fig. 1). The ACL was classified as absent when there was complete loss of continuity of its fibers. When the fibers of this ligament still presented continuity from its femoral origin to its tibial insertion, the ligament was considered present. In the case of ACL presence, no attempt was made to classify the case according to the degree of macroscopic degeneration (preserved vs. degenerated), as this classification is extremely subjective.[10]

The ACL condition (presence or absence) was correlated with the five grades Ahlbäck classification; the assessment in varus and valgus knees was made separately.

The presence or absence of the ACL was correlated with the parameters age, gender, and tibiofemoral angle.

Statistical analysis

The chi-squared and Fisher's exact tests were used for analysis of parametric data. The Kruskal–Wallis and the G2-Wilks tests were used nonparametric data. p-Values <0.05 were considered as significant.

Results

In 27/89 patients (30.4%), the ACL was not detectable during surgery; it was present in the remaining 62 cases.

The ACL was absent in 19/72 (26%) of the female patients and in 9/17 (52%) of the male patients. Fisher's test indicated statistical significance ($p = 0.0442$; Table 2).

Table 3 – Correlation between the ACL preservation status and the Ahlbäck classification (varus).

Ahlbäck classification	ACL preservation status			Statistical analysis
	Absent	Present	Total	
I	0	7	7	$p < 0.0001$
II	3	8	11	
III	3	26	29	
IV	10	2	12	
V	5	0	5	

ACL, anterior cruciate ligament.

Table 4 – Correlation between the ACL preservation status and the Ahlbäck classification (valgus).

Ahlbäck classification	ACL preservation status			Statistical analysis
	Absent	Present	Total	
I	1	8	9	$p = 0.307$
II	1	3	4	
III	1	3	4	
IV	4	3	7	
V	0	1	1	

ACL, anterior cruciate ligament.

The ACL was absent in 7/25 (28%) of cases of valgus knee and in 16/64 (35.5%) of varus knee, with no statistical significance at the G2-Wilks test ($p = 0.24$).

No statistically significant correlation was observed between varus greater than or less than 10° and the ACL preservation status according to Fisher's test ($p = 0.202$). Valgus knee greater than or less than 15° was also not correlated with the state of the ACL (Fisher's exact test, $p = 0.275$).

Individuals with preserved ACL had a mean age of 69.9 years (SD ± 7.9); in turn, the mean age of patients with absent ACL was 70.1 (SD ± 6.7), with no statistical difference by Student's t-test ($p = 0.385$).

In cases of knee arthrosis with varus deformity, the analysis of the correlation between the Ahlbäck radiographic classification and the ACL status indicated a relationship between grades I through III and the presence of ACL in 41/47 (86.7%) of cases; and between grades IV and V and the absence of the ACL in 15/17 (88.2%) cases (G2-Wilks test; $p < 0.0001$; Table 3).

In cases of valgus deformity, no statistically significant correlation was observed between the Ahlbäck radiographic classification and the condition of the ACL. In knees classified as grades I through III, the ACL was present in 14/17 (82.4%); in those classified as grade IV and V, the ACL was present in 4/8 (50%) patients (Table 4).

Discussion

Ideally, a classification in the medical field should be able to identify the severity of the injury assessed and have predictive value, as well as assist in therapeutic indication. Furthermore, it should be simple, easy to remember, and present high levels of inter- and intra-observer agreement.[3,11] In practice, such a classification is rarely available.

Studies assessing radiographic classifications that evaluate arthritic degeneration in knees have demonstrated that narrowing of the tibiofemoral joint space was the most sensitive parameter in detecting articular involvement.[12–15] This parameter presents high intra- and inter-observer correlation, and is more reliable to radiographically grade arthrosis than subchondral sclerosis.[13]

The Kelgren–Lawrence (KL),[14,15] the joint space narrowing (JSN),[14] and the American College of Rheumatology (ACR)[14] classifications are reliable for early diagnosis of knee arthrosis and for monitoring the clinical-radiographic evolution. For these reasons, the classifications are widely used by rheumatologists in the clinical management of knee disorders.

When arthrosis progresses, no longer being amenable to conservative treatment and requiring surgical treatment, the radiographic changes also worsen. The KL, JSN, and ACR ratings would no longer be so useful to the orthopedic surgeon, as the higher grades described by them are not detailed enough to aid in the choice of the most appropriate surgical option. For example, grade 4, the highest in the KL classification, is defined by an evident reduction in the tibiofemoral area, with evident subchondral sclerosis and osteophytes. This definition corresponds to grade II in the Ahlbäck classification.[15]

Although widely used, some studies[3,4] indicate that the Ahlbäck classification presents low reproducibility and poor differentiation between grades I through III.

Weidow et al.[4] reported that, for Ahlbäck classification purposes, signs of bone contact in radiographs are more important than the tibiofemoral narrowing measurement. These authors described that patients who still disclose an evident radiographic tibiofemoral space and who would be initially classified as grade I could present significant bone friction and joint wear during surgery. In fact, such a case would functionally be a grade III. In other words, these researchers have shown that it would be difficult to differentiate Ahlbäck grades I through III.

In their classical article, Keyes et al.[2] established that in varus knees rated as Ahlbäck grades I to III, the ACL would

generally be present, while in grade IV, the ACL injury would determine a greater destruction of the medial plateau in its central and posterior portions, and would eventually evolve to anterior subluxation of the tibia (grade V). Grades IV and V would present similarities and would be, by definition and radiographically, significantly different from grades I to III.

Orthopedic surgeons widely use the Ahlbäck classification, adopting it as a guideline for the choice of surgical treatment. According to Keyes et al.,[2] grades I through III are amenable to treatment by osteotomy or unicompartmental prosthesis, although a total prosthesis can be safely used when factors such as age and level of physical activity are taken into account. In turn, due to the association of ACL insufficiency and more severe joint destruction, grades IV and V should be treated with total knee prosthesis.

In their seminal article, Keyes et al.,[2] despite having assessed 200 cases of medial knee arthrosis, describe in the text only 50 knees in which the presence of the ACL was actually assessed; there is no reference in this regard for the remaining 150 cases. This fact raises the question of what the real correlation between the ACL preservation status and Ahlbäck classification effectively would be. The original article gives the initial impression that the ACL would be present and functional in almost 100% of cases classified as Ahlbäck I through III. Since an extensive search in literature could not find any other studies that assessed the correlation between this classification and the presence of the ACL, which would confirm or disprove the findings of Keyes et al.,[2] the authors decided to conduct the present study.

The absence of ACL leads to greater destruction of the medial knee plateau.[2,16] Moschella et al.,[16] in a study of the joint wear pattern in 70 varus knees undergoing TKA, demonstrated that in cases where the ACL was present, the joint wear would be central in the medial plateau. However, when the ACL was deficient, the wear would be in the anteroposterior plane of this plateau, and therefore wider. Similar findings were reported by Garrido et al.[17]

Lee et al.[18] reported that ACL absence would be associated with a significant involvement of the articular cartilage of the contralateral compartment in patients with medial knee arthrosis. This would indicate a higher severity due to the joint involvement of both knee plateaus.

In the present study, it was shown that the ACL was present in 86.7% of cases described as Ahlbäck grades I, II, and III while in grades IV and V the ACL was absent in 88.2% of cases in varus knees; this difference was statistically significant ($p < 0.0001$). These results are in agreement with Keyes et al.[2] and demonstrate that the Ahlbäck classification can provide a relatively reliable idea of the ACL condition and is therefore useful in surgical planning in cases of medial compartment knee arthrosis.

In this study, the Ahlbäck classification was not able to predict the presence or absence of the ACL in knees with valgus deformity and arthrosis. In grades I through III, the ACL was present in 82.4% of the cases, similar to the rates found in knees with varus deformity, while in grade IV and V, it was absent in only 50%. These less reliable results are partially due to the fact that the radiographic femoral bone contact cannot be adequately shown in osteoarthritis of the lateral compartment.[4] This fact shows that the use of Ahlbäck classification would not be suitable for assessing cases of gonarthrosis in valgus,[4] despite its widespread use in everyday clinical practice.[3,4,11]

In the present study, the ACL was absent in 30.3% of the sample, similar to that observed by Allain et al.[10] and Lee et al.,[18] who described absence of ACL in 40% and 39%, respectively, in their series of knee arthroplasties.

No studies that assessed the ACL preservation status and its correlation with clinical or radiographic parameters were retrieved in the literature. In the present study, it was statistically shown that males had a higher prevalence of absent ACL observed during knee arthroplasty surgery than women (52% vs. 26%).

There is a growing movement in orthopedics for surgical procedures to be as little aggressive as possible; the goal is to intervene effectively in the affected and pathology-generating structures. This trend is evident in the cases of medial gonarthrosis in which the ACL is competent; in these cases, osteotomy or partial arthroplasty procedures are preferred to total knee arthroplasty.[2,5,18] Another current area of study is the use of total knee prosthesis with maintenance of both cruciate ligaments, which must obviously be functional for the proper functioning of the arthroplasty.[6,7] These trends highlight the need for assessing ACL integrity during surgical planning.

It is important to note that ACL integrity can also be evaluated by magnetic resonance imaging.[12,14] Nevertheless, despite being an excellent imaging method, it is an expensive method with a long waiting queue and unfortunately it is seldom accessible to patients from the Brazilian Public Health System (Sistema Único de Saúde [SUS]), except for some university hospitals and reference centers. This reinforces the importance of information that can be obtained through simple knee radiographs.

A limitation of the present study is the fact that it is based on the use of Ahlbäck classification, which some authors[3,4,11] describe as having low levels of intra- and inter-observer correlation. In order to increase the reliability of this study, the cases were classified in agreement by two specialists in knee surgery who have extensive experience in using this classification.[3,4] Furthermore, the results were assessed in two more homogeneous groups (Ahlbäck grades I to III and another formed by grades IV and V), which would increase the reproducibility and reliability.[3,4] A positive finding of the present study is the fact that the results confirmed the usefulness of the Ahlbäck classification to predict ACL preservation status in varus knees, which has not been demonstrated in cases of valgus knees.

Conclusions

1. In the case of medial compartment gonarthrosis, the Ahlbäck classification is a reliable parameter to predict ACL status (present or absent).
2. In valgus knee arthrosis, the ACL status was not predicted by the Ahlbäck classification.

Conflicts of interest

The authors declare no conflicts of interest.

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