

Work, sport activities, and factors associated with medial meniscal tears in non-athletic subjects

Actividades deportivas y laborales, y factores asociados a rotura del menisco medial en sujetos no deportistas

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Abstract

Background: It is known that late surgical reconstruction of the anterior cruciate ligament (ACL) is associated with a medial meniscal (MM) tears. However, the association between factors relating to sports and work activities and joint instability has not been examined in non-athletic subjects. **Objective:** The objective of the study was to compare sports and work activities and other factors associated with MM tears, in subjects with ACL rupture. **Methods:** A case-control design study, of patients with ACL injury, 140 cases and 140 controls with and without a rupture of MM respectively, were included in the study. Sociodemographic factors, sports, and work activities were compared. **Results:** The independent factors associated with MM ruptures were continuing sports activities after injury (odds ratio [OR]: 3.6; 95% confidence interval [95% CI]: 1.7-7.9), joint instability (OR: 2.2; 95% CI: 1.8-2.6), time between injury and surgical intervention (time of evolution) (OR: 1.003; 95% CI: 1.0-1.01), and age (OR: 1.1; 95% CI: 1.03-1.1). **Conclusions:** Intense activities of daily life such as continuing sports activities, after an ACL injury in non-athletic factory workers subjects, without previous training, as well as, age, joint instability, and surgical delay are risk factors for rupture of MM.

Key words: Arthroscopy. Risk factors. Anterior cruciate ligament. Menisci tibial. Knee.

Resumen

Antecedentes: Se sabe que la reconstrucción tardía del ligamento cruzado anterior (LCA) se asocia a rotura del menisco medial (MM). Sin embargo, la asociación entre factores referentes a las actividades deportivas, laborales e inestabilidad articular no se ha examinado en sujetos no deportistas. **Objetivo:** Comparar las actividades laborales, deportivas y otros factores asociados a rotura del MM en sujetos con rotura del LCA. **Método:** Diseño de casos y controles, de sujetos con rotura del LCA; 140 casos y 140 controles con y sin rotura de MM, respectivamente. Se compararon factores sociodemográficos, actividades deportivas y laborales. **Resultados:** Los factores independientes asociados a roturas del MM fueron el continuar con actividades deportivas después de la lesión (razón de momios [RM]: 3.6; intervalo de confianza del 95% [IC 95%]: 1.7-7.9), la inestabilidad articular (RM: 2.2; IC 95%: 1.8-2.6), el tiempo de evolución entre la lesión y la reconstrucción (RM: 1.003; IC

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95%: 1.0-1.01) y la edad (RM: 1.1; IC 95%: 1.03-1.1). **Conclusiones:** Actividades intensas de la vida diaria, como continuar con deportes, después de una lesión del LCA en sujetos obreros, no deportistas, sin entrenamiento previo, así como la edad, el retraso en la reconstrucción y la inestabilidad articular, son factores de riesgo para rotura del MM.

Palabras clave: Artroscopia. Factores de riesgo. Ligamento cruzado anterior. Meniscos tibiales. Rodilla.

Introduction

Anterior cruciate ligament (ACL) rupture is a common injury associated with medial meniscus (MM) tear¹. MM is a secondary stabilizer that prevents anterior translation of the knee when ACL is deficient. In the presence of this deficiency, MM tears overtime, when it replaces ACL stabilizing function². Thus, performing the reconstruction before 1 year after ACL³ rupture occurred is recommended, since delay in its reconstruction is associated with MM tear. However, this association with other factors such as those of intense activities of daily life in non-athletic subjects who work as operators, who subject the knee to constant joint instability, both at work and when practicing sports, has not been examined in depth, even when these factors might interact with the waiting time between ACL injury and its reconstruction and cause chronic knee injuries, thus resulting in inability to work. Among the risk factors, age is associated with MM tear when there are treatment delays⁴. Subjects older than 35 years with ACL rupture are reported to experience more pain and disability⁵, in addition to the appearance of rapid degenerative changes in the knee when waiting time for its reconstruction is longer than 12 months⁶. Furthermore, the male gender is a factor that predisposes to MM tear⁷. Similarly, the number of joint instability episodes accumulated before ACL reconstruction is a factor associated with MM tear⁸. Thus, age, the male gender, late reconstruction after more than 12 months, and body mass index (BMI) are risk factors for MM tear⁹. Regarding work in conjunction with sport activities, using stairs more than 30 times a day, squatting during the work-day¹⁰, obesity and sports such as soccer have been reported to be risk factors for MM tear¹¹ in subjects without ACL injury, with inconclusive evidence on whether occupational or sport factors or both are associated with MM tear. In addition, it remains to be identified whether these activities that are part of a worker's active life¹², together with constant joint instability, gender¹³, BMI, and prolongation of time between ACL injury and its reconstruction, predispose to MM tear. Therefore, the main purpose of this study

was to determine whether there is an association between work and sports activities and other possible risk factors with MM tear in non-athletic subjects with ACL rupture.

Methods

Study population and design

A case-control study conducted in the knee arthroscopy department of the trauma and orthopedics hospital No. 21 of the Mexican Institute of Social Security in Monterrey, Nuevo León, Mexico. During the period from 2016 to 2017, using simple random probability sampling, non-athletic patients with ACL rupture, older than 18 years, undergoing ACL arthroscopic reconstruction, and with complete surgical records, were included in the study. Subjects with previous surgery, previous injuries, acute MM injury (clinically diagnosed or by imaging), ACL fracture – avulsion, and knee deformities were excluded from the study. The sample size was calculated aided by the EpiData 4.1 program. Delayed reconstruction of more than 12 months from ACL injury to reconstruction was considered as exposure factor. For an expected frequency of cases of 68%^{5,12,14,15}, an odds ratio (OR) of 2.0 to be detected and a 1:1 ratio, 140 participants were required per group. Before carrying out the study, approval from the hospital's Local Research and Research Ethics Committee was obtained, with registration number R-2016-1903-15, and all participants signed an informed consent document.

Configuration of the groups

Cases and controls were obtained from a list of patients who underwent arthroscopic reconstruction surgery. The group of cases was those who underwent reconstruction and had a finding of MM tear, and the control group was patients with ACL rupture who underwent reconstruction, without MM tear being found, thus was MM and ACL rupture confirmed. Therefore, ACL rupture, and the presence or not of MM tear, should have been properly recorded, documented, and depicted after having undergone surgery.

Assessment

The information, which was obtained from surgical reports, was evaluated in a blinded and independent manner by three resident physicians (with previous training) who were foreign to the research. Pre-surgical diagnosis was established by certified physicians (with arthroscopic surgery training), who carried out physical examination and assessed the imaging studies of those patients who had them available. To contrast this information, agreement between pre-operative diagnosis and the findings reported on surgical records was analyzed, with consistency being found for a Cohen kappa index of 0.81. To collect patient information, they were directly interviewed in the weeks following the operation; the purpose of the study was explained and a specifically designed questionnaire was applied. Investigated data included gender, age, work activity, sport activity, type of sport, mechanism of injury, latency time from injury to reconstruction surgery, and instability episodes (defined as sensation of abnormal mobility due to knee subluxation). Patients were also asked if they worked in the standing position, if they worked seated, if they trained for sports and if they had continued with sport activities after the injury. Evolution or latency time since the injury was obtained from patient interview. An injury incident was considered when there was a twisting of the knee with a "pop" sound or direct trauma, both accompanied by knee joint effusion or edema with functional disability. Weight and height were recorded in light clothing, without shoes, on an analog scale with calibration verification and on a stadiometer, on two occasions, and the mean was taken as final measurement, to then calculate the BMI (kg/m^2).

Statistical analysis

For quantitative variables comparative analysis, Student's t-test or Mann-Whitney's U-test was used according to normality and homoscedasticity assumptions. Pearson's Chi-square test was used to compare frequencies and percentages. To assess the magnitude of association, the OR was measured, with its 95% confidence interval (CI). A multivariate analysis was carried out using a logistic regression model to discriminate those factors that were significant in the bivariate analysis. The significance value was $\alpha < 0.05$. Statistical analysis was performed with the SPSS software, version 22 (SPSS, Chicago, IL, USA).

Results

Of the potential patients to be enrolled in the study, 363 were eligible, but 280 were included (Fig. 1); out of them, 247 (88.2%) were male. Median age was 29 years, with an interquartile range of 25-34. Regarding the occupation, 143 (55%) were laborers. As for sports activities, 118 (43.1%) practiced soccer, 150 did not practice sport activities (53.6%), 12 practiced other sports, and 204 (72.9%) practiced sports without prior training. As regards possible occupational risk factors, 67 (23.9%) had a sedentary or predominantly sitting job, 209 (74.6%) worked most of the time on their feet, 203 (72.5%) carried weight at work, and 30 (10.7%) used stairs continuously in their job. In the group of cases, there were significant differences in the comparison of the latency time from ACL injury to reconstruction surgery, with a difference of 34 days with regard to the control group ($p < 0.001$); evolution time from injury onset in the overall population had a median of 152.5 days, with an interquartile range of 115.5-370.75 days. When analyzing other possible risk factors associated with MM tear in the cases, they were observed to be older, heavier and to have a higher BMI (Table 1). In addition, other possible factors associated with MM tear were compared, such as instability episodes, sports training, time spent in sport activities, and continuing with sport activities after the injury, which showed statistically significant differences (Table 2). As for occupational risk factors, working in the sitting position was observed to be a probable protective factor, while working in the standing position and carrying weight were possible risk factors (Table 3). In the multivariate analysis using the logistic regression model, age, prolonged latency time, instability episodes, and continuing with sport activities were significant (Table 4).

Discussion

In this study, we observed that if latency time from injury to ACL reconstruction surgery is long, it is closely associated with MM tear complication, as in the study by Chhadia et al.¹⁶ who determined a twice as high risk of MM tear in subjects with a 12-month latency time to reconstruction. Anstey et al.¹⁴ referred that, 6 months after the injury, the prevalence of MM tear increases from 4.1% to 16.7%. Other studies report that, after 12 months of evolution, the incidence

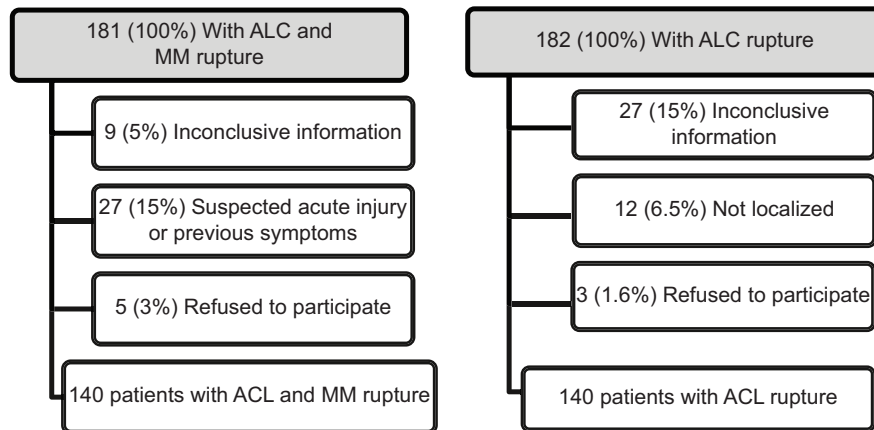


Figure 1. Study flowchart. ACL: anterior cruciate ligament; MM: medial meniscus.

Table 1. General characteristics of 280 patients with and without medial meniscus tear (with anterior cruciate ligament rupture)

Characteristic	With medial meniscus tear (n = 140)	Without medial meniscus tear (n = 140)	p
Age (years)	32 (25-39)*	28 (23-31)*	< 0.001 [†]
Male gender	127 (91%)	120 (86%)	0.19 [‡]
Smoking	46 (33%)	43 (31%)	0.70 [‡]
Weight (kg)	84 (75-94)*	78 (70-90)*	0.02 [†]
Body mass index (kg/m ²)	28.8 (26.5-31.2)*	27.4 (24.9-30)*	0.004 [†]
Height (m)	1.7 (1.65-1.75)*	1.7 (1.65-1.75)*	0.77 [†]
Latency time	175 (116-414)*	141 (115-181)*	< 0.001 [†]
Type of sport activity			
No sport activity	53 (38%)	97 (69%)	< 0.001 [‡]
Other sports	9 (6%)	3 (2%)	
Soccer	78 (56%)	40 (29%)	

*Median and interquartile range.

[†]Mann-Whitney's U-test.

[‡]Chi-square test.

Table 2. Sport activities and events in 280 patients with and without medial meniscus tear (with anterior cruciate ligament rupture)

Activity	With medial meniscus tear (n = 140)	Without medial meniscus tear (n = 140)	OR	95% CI	p
Instability episodes per week	3 (0-4)*	0 (0-2)*	-	-	< 0.001 [†]
Indirect injury mechanism	121 (86%)	113 (81%)	1.5	0.8-2.9	0.20 [‡]
Continuing with sports	87 (62%)	43 (31%)	3.7	2.2-6.1	< 0.001 [‡]
Sports training	57 (41%)	31 (22%)	1.4	1.4-4.1	0.001 [‡]
Sport hours	3 (0-4)*	0 (0-2)*	-	-	< 0.001 [†]

CI: confidence interval; OR: odds ratio.

*Median and interquartile range.

[†]Mann-Whitney's U-test.

[‡]Chi-square test.

of MM tear increases to 80%¹⁷, and that for each month of waiting time between the injury and its reconstruction, it increases 1%¹⁸ and for each year 6%¹⁹.

As for age and latency time, Magnussen et al.²⁰ stated that subjects with ACL rupture older than 22 years with a waiting time for surgery longer than 12

Table 3. Work activity characteristics in 280 patients with and without medial meniscus tear (with anterior cruciate ligament rupture)

Activity	With medial meniscus tear (n = 140)	Without medial meniscus tear (n = 140)	OR	95% CI	p
Drives at work	6 (4%)	11 (8%)	0.5	0.2-1.5	0.21*
Works seated	24 (17%)	43 (31%)	0.5	0.3-0.8	0.008*
Works standing up	113 (81%)	96 (69%)	1.9	1.1-3.3	0.02*
Carries weight	111 (79%)	92 (66%)	2.0	1.2-3.4	0.01*
Uses stairs	18 (13%)	12 (9%)	1.6	0.73-3.4	0.25*

CI: confidence interval; OR: odds ratio.

*Chi-square test.

Table 4. Variables in the logistic regression equation for association. The presence or absence of medial meniscus lesion was taken as reference for analysis

Step 4	B	SE	Wald χ^2	df	p	Exp B	95% CI
Age	0.080	0.026	9.524	1	0.002	1.1	1.04-1.14
Continuing with sport activities	1.285	0.397	10.463	1	0.001	3.6	1.7-7.9
Latency time	0.003	0.001	4.533	1	0.033	1.003	1.0-1.01
Joint instability	0.745	0.089	69.662	1	< 0.001	2.2	1.8-2.6
Constant	-7.680	1.052	53.320	1	< 0.001	0.000	

B: logistic regression coefficient; SE: standard error; Exp B: exponent B (odds ratio); df: degrees of freedom; CI: confidence interval; χ^2 : Wald Chi-squared test.

weeks develop MM tear more frequently. Moreover, Tandogan et al.⁴ observed that patients with complex meniscus injuries are 3 years older than those with simple injuries. In this investigation, cases had a median age of 32 years (range: 18-51) and a latency time of 175 days; this may be due to the degeneration that occurs with age in the meniscus tissue, which together with ACL reconstruction delay is associated with MM tear.

On the other hand, Brambilla et al.⁹ determined that ACL injury plus an elevated BMI is associated with MM tear, in coincidence with this report, where the cases with MM tear were observed to have higher BMI than controls, although both cohorts had overweight.

Gender is another risk factor, and this is supported by Kluczynski et al.¹³ who referred that MM tear is twice more common in males. Brambilla et al.⁹ estimated similar data (OR: 1.4-2.6). In this report, we had a high prevalence of males (88.2%), and thus no differences were observed, which shows that in our

population, males have more ACL ruptures due to sport activities (in our study, 78.8% of women did not practice sports).

Another risk factor is joint instability episodes. Kluczynski et al.⁸ observed that more than 4 instability episodes, without specifying intensity or time, are strongly associated with MM tear. We obtained a median of three episodes per week, and thus, it is likely to be more frequent than described. Similarly, Joseph et al.²¹ claimed that subjects who do not practice sport activities and suffer a delay in ACL reconstruction are equally susceptible to suffering a MM injury, and thus, the hypothesis arises on whether joint instability by itself might predispose to MM injury. Therefore, comparative studies should be carried out with the use of orthopedic devices that avoid abnormal joint translation and thus being able to assess the influence of other risk factors.

As for sport activity, Tandogan et al.⁴ stated that practicing soccer is associated with MM tear in 65% of subjects in their report, but found no association with the level of previous training, in agreement with this analysis, where MM tear was more common in subjects who played soccer. However, regarding the level of training, we observed that total hours of sport practice per week, sport training and continuing to recreationally practicing sports after the injury were factors associated with MM tear ($p = 0.001$). By the same token, Chen et al.¹² referred that subjects who continue with intense activities after ACL injury, including those who regularly practice high-intensity sports, in comparison with those who are inactive or practice lower intensity sports, experience MM tear more often. Furthermore, Baker et al.¹⁰ analyzed sport and occupational activities, but in subjects without ACL rupture, and pointed out that practicing sports with high functional demand, such as soccer,

or constantly squatting or kneeling at work, and being obese, are associated with MM tear; moreover, they refer that subjects who kneel or squat and who climb stairs more than 30 times a day during the workday have a higher association with MM tear¹¹. We found that continuously using stairs during work was not significant, and we had no subjects who repeatedly squat or kneel at work. However, having subjects who carried weight or were on their feet during the workday were frequent and were associated with MM tear. Working in the sitting position was a possible protective factor against MM tear; in this report, 52.2% of the subjects who worked seated did not practice any sporting activity. Therefore, one point of discussion to consider is whether work activities should be continued in this type of subjects or if they should go on disability leave, with the costs this entails.

Limitations of this study include that joint cartilage and lateral meniscus injuries were not taken into account and that patients at the onset of the injury did not have an MRI practiced confirming or ruling out MM tear simultaneously with ALC rupture, which may have caused a classification bias. Another aspect that was not investigated was the level of education, to evaluate its possible effect on relevant search for specialized medical care.

The strengths are that the sample was representative and homogeneous, the study population was simultaneously selected, and risk factors that have been analyzed in isolation in other research works were investigated.

Conclusions

A common factor in the type of study population was that the knee joint underwent greater biomechanical stress due to intense activities of daily living and that sport activities were continued after an ACL tear in non-athletic subjects who are operators, without adequate physical conditioning. Being older, suffering delays in ACL reconstruction and constant joint instability could be risk factors for MM tear. Therefore, sports with high functional demand should be avoided in this type of subjects, since work activity could by itself predispose to MM tear, and although in this report, it was not an independently associated factor, it should be taken into consideration, and carrying out more research on the subject is, therefore, recommended.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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Ethical disclosure

Protection of people and animals. The authors declare that no experiments were performed on humans or animals for this research.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained informed consent from the patients and/or subjects referred to in the article. This document is in the possession of the corresponding author.

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