

The Effect of the Cause of Trauma, Sports Activity As Well As Body Mass on Lesions of the Knee Joint Evaluated Using Magnetic Resonance

Dr. Tanja Petrovska

Abstract: Introduction: The most common cause is stated to be a fall, bend as well as spontaneous pain. The changes which lead to pain in the knee may be detected with a non-invasive method such as magnetic resonance. The aim of this study is to see whether a linkage exists between the pain intensity and the degree of the lesion on any structure of the knee. Whether body mass plays a significant role in relation to the manner in which the injury occurred. Material and Methods: Our study included 261 patients which met our inclusion criteria for participation in this study. All patients signed an informant consent for participation in the study. The study will involve a prospective analysis with Magnetic Resonance Imaging of the knee for a period of 1 year using an MRI of 1.5 T. The data is acquired using a questionnaire regarding the injury filled by the patient. In our study 261 knee MRIs were processed and analysed in patients with acute injury to the knee, with a negative radiograph of the knee and persistent pain not longer than 1 month despite undergoing a conservative treatment. We analyze in the study the relationship between demographic characteristics of patients with trauma to the knee and the manner in which the injury occurred. Results: With regard to the gender distribution: 65.13% were male The manner of injury in the greater part of the subjects was bending (40.23%). In terms of localization of the pain, the majority of subjects reported that they felt the pain in the medial part of the knee (47.13%). When analysing MRIs of the knees, the majority showed a lesion on the cartilage of the medial condyle on the femur in 88 (33.72%) subjects. In our study the MRI findings showed a lesion on the posterior horn of the medial meniscus in 175 (67.05%) subjects. With an MRI findings of a lesion on the ACL were present in around 40% of the subjects. Patients with lesions on the ACL had a significantly more frequent occurrence of bone oedema ($p=0.043$). All patients with a combined trauma to the anterior cruciate ligament and the posterior horn of the medial meniscus also had a bone oedema Type 1 and Type 2. Conclusion: Age and body weight do not have an impact on the manner in which the trauma occurs and the type and grade of the lesions of the knee. Males are more prone to sports traumas. The intensity of pain does not depend on the cause of injury. All patients with a combined trauma to the anterior cruciate ligament and the posterior horn of the medial meniscus had a bone oedema Type 1 and Type 2. Bone oedemas should always be searched during an MRI analysis of the knee as it can lead to finding the lesion.

Keywords: Knee trauma MRI, BMI, ACL, medial meniscus

1. Introduction

The knee joint falls in the group of synovial (diarthrosis) joints. In everyday clinical practice pain in the knee is a common complaint from patients, especially in young patients. The most common cause is stated to be a fall, bend as well as spontaneous pain. The changes which lead to pain in the knee may be detected with a non-invasive method such as magnetic resonance. Using this method, we can follow direct signs of a lesion but also indirect signs which help in the localization of the lesion. Bone oedema, as an indirect sign is often a guide when detecting lesions of the knee whether they are ligament, meniscus or cartilage lesions. The structures of the knee which are covered with cartilage or other surrounding structures are not available for arthroscopic evaluation.

Until the year 1980 these injuries were indirectly diagnosed however, with the use of magnetic resonance the diagnostic of these injuries of the knee became more exact [1].

The aim of this study is to see whether a linkage exists between the pain intensity and the degree of the lesion on any structure of the knee. Whether body mass plays a significant role in relation to the cause of trauma to the knee.

2. Materials and Methods

Our study included 261 patients which met our inclusion criteria for participation in this study.

All patients signed an informant consent for participation in the study. The study will involve a prospective analysis with Magnetic Resonance Imaging of the knee for a period of 1 year using an MRI of 1.5 T. The data is acquired using a questionnaire regarding the injury filled by the patient.

The gradation of pain is divided into three degrees: 1-3-0, 4-6-1 and 7-10-2

The cause of trauma was evaluated as: during a fall-0, bending of the knee-1, sports injury-2

The occurrence of the pain was graded as: spontaneous pain-0, pain occurring with movement-1, pain occurring when ascending stairs-11, pain occurring when descending stairs-12, locking of the knee-13.

The index of body mass is general and will be measured using a table.

3. Results

In our study 261 knee MRIs were processed and analysed in patients with acute injury to the knee, with a negative

radiograph of the knee and persistent pain not longer than 1 month despite undergoing a conservative treatment.

With regard to the gender distribution: 170 (65.13%) male patients and 91 (34.87%) female patients.

Subjects were aged 19-50 years; the average age was 33.77 ± 10.2 years. We analysed age within three age groups: subjects from 19-29 years, 30-39 years and 40-50 year. The age group 40-50 years contained the largest number of patients with acute trauma to the knee joint 35.25%.

Body mass index (BMI) indicated the majority of the subjects with a BMI from 18.5-24.9 (41.76%), followed by 37.93% of subjects with an index of 25-29.9, 18.39% of the subjects had a BMI greater than 30, 1,91% with a BMI lower than 18.5. Table 1 shows the results of the study of the relationship between demographic characteristics of patients with trauma to the knee and the manner in which the injury occurred.

The cause of injury in the greater part of the subjects was bending (40.23%). The distribution of the type of pain offered the most common representation of pain to be with movement (72.41%).

In terms of localization of the pain, the majority of subjects reported that they felt the pain in the medial part of the knee (47.13%). 42.14 % of the subjects graded the pain as weak, i.e. on a scale of 1 to 10 they answered between 1 and 3, while 16.09% of the subjects reported strong pain, grading it between 7 and 10.

89 (34.1%) of the subjects. Table 2 shows the results obtained by analysing the findings of the magnetic resonance imaging which refer to the presence of an oedema in the bone structures of the knee joint. Bone oedema can only be analysed using an MRI of the knee and its gradation of Type 1 and Type 2 can help in the prognosis of the evolution of changes to it [23]. The presence of an oedema in the medial condyle of the femur was detected in 33 (12.64%) patients, on the lateral condyle of the femur in 42 (16.09%) patients, oedema on the medial segment of the tibia plateau in 14 (5.36%) patients, oedema on the lateral segment of the tibia plateau was diagnosed in 16 (6.13%) patients. MRI findings showed that oedema on the diaphysis of the femur and tibia was present in 21 (8.05%) and 7 (2.68%) of the subjects analysed. In 30 (11.49%) patients with internal distortions of the knee joint, MRI findings show oedema on the medial facet of the patella, and in 16 (6.12%) patients an oedema was present in the lateral facet on the patella.

Type 2 oedemas were the most common MRI finding on the medial facet on the patella detected in 20 (7.66%) subjects, followed by the lateral condyle of the femur in 19 (7.28%) subjects, medial condyle of the femur in 16 (6.13%) subjects, lateral facet of the patella in 6 (2.29%) subjects, medial segment of the tibia plateau in 5 (1.91%) subjects, lateral segment of the tibia plateau in 2 (0.77%) subjects and in one subject (0.38%) the MRI finding showed an oedema on the diaphysis of the tibia.

Table 1

Patient characteristics	
Gender n(%)	
Male	170 (65.13)
Female	91 (34.87)
Age groups n(%)	
19 – 29	101 (38.7)
30 – 39	68 (26.05)
40 – 50	92 (35.25)
Mean±SD (33.77±10.2)	min – max (19– 50)
Height n(%)	
160 – 170	81 (31.03)
171 – 181	102 (39.08)
182 – 201	78 (29.88)
Weight n (%)	
55 – 70	68 (26.05)
71 – 86	111 (42.53)
87 – 102	82 (31.42)
BMI n (%)	
< 18.5	5 (1.91)
18.5 – 24.9	109 (41.76)
25 – 29.9	99 (37.93)
> 30	48 (18.39)

With analysis of magnetic resonance of the knees data was obtained regarding the existence of effusion in the knee in



Figure 1: Bone oedema type 1



Figure 2: Lesion of the posterior horn of the medial meniscus

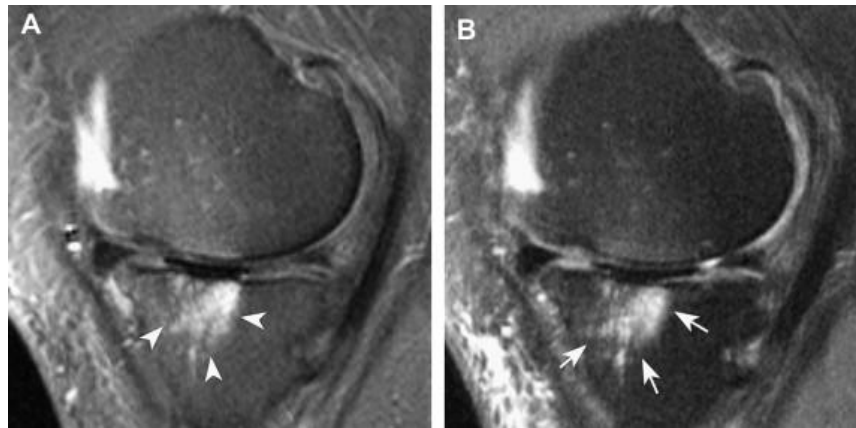


Figure 3: Subchondral oedema of the medial part of the tibia



Figure 4: Complete lesion of the ACL

Table 2

Variable	
Cause of trauma n (%)	
Fall	84 (32.18)
Bending	105 (40.23)
Sports injury	72 (27.59)
Type of pain n (%)	
Spontaneous	15 (5.75)
During movement	189 (72.41)
Ascending stairs	44 (16.86)
Descending stairs	3 (1.15)
Locking of the knee	10 (3.83)
Localizing the pain n (%)	
Lateral	34 (13.03)
Medial	123 (47.13)
Anterior	78 (29.88)
Posterior	26 (9.96)
Intensity of pain n (%)	
1 – 3	110 (42.14)
4 – 6	109 (41.76)
7 – 10	42 (16.09)
Athlete n (%)	
Athlete	91 (34.87)
Other	170 (65.13)
Effusion n (%)	
No	172 (65.9)
Yes	89 (34.1)

With an injury to the knee joint it is common for the cartilage elements of the knee to suffer as well. Gradation of lesions on the cartilage of the knee is conducted according to ICRS classification [3].

Table 3 shows the results obtained with analysis of the findings from MRI regarding the detection of lesions on the joint cartilage.

Table 3

Variable	
R – MCF - medial condyle of the femur n(%)	
None	173 (66.28)
Oedema	11 (4.21)
Ribbed	10 (3.83)
h < 50%	48 (18.39)
h > 50%	15 (5.75)
Chondral defect	4 (1.53)
R – LCF - lateral condyle of the femur n(%)	
None	208 (79.69)
Oedema	14 (5.36)
Ribbed	7 (2.68)
h < 50%	26 (9.96)
h > 50%	3 (1.15)
Chondral defect	3 (1.15)
R – MET - medial segment of the tibia plateau n(%)	
None	235 (90.04)
Oedema	1 (0.38)
Ribbed	3 (1.15)
H < 50%	17 (6.51)
h > 50%	5 (1.92)
R – LET - lateral segment of the tibia plateau n(%)	
None	254 (97.32)
Oedema	2 (0.77)
Ribbed	1 (0.38)
H < 50%	4 (1.53)
R – MFP – medial facet on the patella n(%)	
None	184 (70.49)
Oedema	8 (3.06)
Ribbed	23 (8.81)
h < 50%	31 (11.88)
h > 50%	14 (5.36)
Chondral defect	1 (0.38)
R – LFP - lateral facet on the patellan(%)	
None	193 (73.95)
Oedema	23 (8.81)
Ribbed	23 (8.81)
h < 50%	17 (6.51)
h > 50%	3 (1.15)
Chondral defect	2 (0.77)

When analysing MRIs of the knees, the majority showed a lesion on the cartilage of the medial condyle on the femur in 88 (33.72%) subjects, of the lateral condyle on the femur in 53 (20.31%), a lesion on the medial aspect of the tibia

plateau in 26 (9.96%) and lesion on the lateral aspect of the tibia plateau in 7 (2.68%) subjects. A change in the cartilage on the patella-medial facet was detected in 77 (2.68%) subjects, a lesion on the cartilage of the lateral facet of the patella in 68 (26.05%) subjects.

With regard to the type of lesion of the articular cartilage, an oedema was most frequently diagnosed as an MRI finding on the lateral facet of the patella (8.81%), only one patient with acute trauma to the knee had an oedema on the cartilage of the medial segment of the tibia plateau.

A ribbed articular cartilage was the most common type of change on the medial and lateral facets of the patella (8.81%). Articular cartilage with a chondral defect of the medial condyle of the femur was the finding of the MRI in 4 subjects, of the lateral condyle of the femur in 3 subjects, on the medial facet of the patella in one subject, while 2 patients had chondral defects on the articular cartilage on the lateral facet of the patella.

Generally, the most common change in the articular cartilage of the knee diagnosed with MRI was a defect that takes up less than 50%, i.e. 48 (18.39%) subjects had this type of finding on the medial condyle of the femur, 2(9.96%) on the lateral condyle of the femur, 17 (6.51%) subjects on the medial segment of the tibia plateau, 4 (1.53%) on the lateral segment of the tibia plateau, 31 (11.88%) on the medial facet of the patella and 17 (6.51%) subjects had a defect on the articular cartilage less than 50% of the lateral facet of the patella.

In addition to lesions of cartilage in the knee, during trauma the menisci in the knee suffer as well (Table 5).

In our study the MRI findings showed a lesion on the anterior horn on the medial meniscus in 34 (13.03%) subjects, a lesion on the posterior horn on the medial meniscus in 175 (67.05%) subjects, lesion on the anterior horn of the lateral meniscus in 36 (13.79%) subjects and a lesion on the posterior horn of the lateral meniscus in 58 (22.22%) subjects.

With regard to the type of meniscal lesion detected with magnetic resonance, the results show that the posterior horn on the medial meniscus is the most common predilection area for all three types of lesions, i.e. in 22.99% of patients with trauma to the knee MRI findings showed type 1 lesions, mucoid degeneration, in 13.03% a type 2 lesion, lesion which runs from the capsule horizontally or to one articular surface and in a high percentage of patients 31.03% the lesion was of type 3, injury running from one to another articular cartilage.

The most common injury with lesions of the knee is encountered in the injury of the anterior cruciate ligament (ACL). Lesions on the ligaments can be accompanied with an oedema and thickening of the same, partial lesion and complete lesion.

With an MRI findings of a lesion on the ACL were present in around 40% of the subjects, i.e. 106 (40.61%), of which 57 (21.84%) had a tear in this ligament.

The remaining three ligaments were affected more rarely, 17 (6.51%) subjects had an injury to the posterior cruciate ligament, 11 (4.22%) had an MRI finding for a trauma to the medial collateral ligament and 7 (2.68%) had an injury to the lateral collateral ligament of the knee (Table 4).

Table 4

Variable	
ACL Anterior cruciate ligament n(%)	
None	155 (59.39)
Oedema	12 (4.59)
Partial	37 (14.18)
Tear	57 (21.84)
PCL Posterior cruciate ligament n(%)	
None	244 (93.49)
Oedema	5 (1.91)
Partial	12 (4.6)
MCL Medial collateral ligament n(%)	
None	250 (95.78)
Oedema	4 (1.53)
Partial	4 (1.53)
Tear	3 (1.15)
LCL Lateral collateral ligament n(%)	
None	254 (97.32)
Oedema	3 (1.15)
Partial	3 (1.15)
Tear	1 (0.38)

The medial and lateral retinaculum of the knee were affected with a lesion in 15 (5.75%) and 5 (1.92%) subjects respectively. Amongst the traumas of the medial retinaculum, the most common was an MRI finding of partial injury (3.45%). In 3 (1.15%) subjects with trauma to the knee, the magnetic resonance showed that the trauma, i.e. the oedema was localized in the area of the attachment of the ligament to the patella. Traumas to the knee rarely occur as isolated events, they are usually complex and occupy more structures.

With regard to the complexity of the trauma to the knee, the results showed that in 119 (45.59%) subjects the trauma was isolated, the remaining 142 (54.41%) subjects showed complex injuries.

In the group of patients without bone oedemas, 86 (37.72%) had a trauma to the ACL, in the group with Type 1 oedema, 10 (58.82%) had a trauma to the ACL, while in the group with Type 2 oedema this percent was 62.5%. Patients with lesions on the ACL had a significantly more frequent occurrence of bone oedema (p=0.043).

In the group of subjects without bone oedemas 65 (28.519%) had injuries to the posterior horn of the medial meniscus grade 3, in the group with Type 1 oedema (35.29%) had injuries to the posterior horn of the medial meniscus grade 3, while in the group with Type 2 oedema this percentage was 62.5%. The statistical analysis showed that patients with lesions on the posterior horn of the medial meniscus grade 3, presented bone oedemas significantly more frequently (p=0.013).

All patients with a combined trauma to the anterior cruciate ligament and the posterior horn of the medial meniscus also had a bone oedema Type 1 and Type 2.

Trauma to the ACL and mm-P	Bone Oedema		
	None	Type 1	Type 2
No	49 (211.49%)	0	0
Yes	179 (78.51%)	17 (100%)	16 (100%)

Patients aged 40 to 50 years more frequently exhibit traumas to the knee as a result of a fall or bend (36.96%, 45.65% respectively) when compared to the remaining two age groups, patients in the age group 30-39 exhibit traumas to the knee more frequently as a result of a fall (41.18%) when compared to participants in the youngest age group, while participants in the age group 19 to 29 exhibit sports injuries to the knee (35.64%) more frequently than patients in the older age groups.

More female than male subjects gave anamnestic data of a fall (36.30% vs 30%) and bending (47.25% vs 36.47%), whereas more male subjects listed sports injury as the cause of injury (33.53% vs 16.48%). In the groups of participants with body mass index lower than 18.5, from 18.5 to 24.9 and from 25 to 29.9 the primary cause of trauma to the knee was bending (80%, 41.28% and 39.39% respectively), whereas a fall was the most common cause of trauma to the knee in the group with the highest body mass index (41.67%).

4. Discussion

In our study the age of subjects had insignificant influence over the cause of trauma to the knee ($p=0.078$)

In participants aged 40-50 years it was more common to have trauma to knee as a result of a fall or bending (36.96%, 46.56% respectively) than in the other two age groups, in participants aged 30-39 we found that knee traumas due to a fall were more common (41.18%) when compared to the youngest age group, in subjects aged 19 to 29 we found a higher percentage of knee traumas to be a result of a sports injury (35.64%) when compared to older subjects. However, these results did not exhibit statistical significance.

Cause of trauma to the knee significantly depended on gender ($p=0.013$). Female patients more frequently than male gave anamnestic data of a fall (36.30% vs 30%) and bending (47.25% vs 36.47%), whereas male patients more frequently than female listed sports as a cause of trauma (33.53% vs 16.48%).

Body weight and height, as well as body mass index did not prove to be statistically significant characteristics of subjects when determining the manner in which trauma to the knee occurred ($p=0.065$, $p=0.49$ and $p=0.38$ respectively). In the groups of participants with body mass index lower than 18.5, from 18.5 to 24.9 and from 25 to 29.9 the primary cause of trauma to the knee was bending (80%, 41.28% and 39.39% respectively), whereas falling was the most common cause of trauma in patients belonging to the group with the highest body mass index (41.67%).

The results from the study showed that the type of pain was significantly different within the three causes of trauma to the knee ($p=0.004$).

73.34% of patients experienced spontaneous pain due to a fall, as opposed to 13.33% as a result of bending and sport activities.

Patients who suffered a knee trauma as a result of bending more commonly experienced pain while moving and ascending stairs. The percentage of subjects experiencing pain while moving was 28.57% in the group with a fall, 40.47% in the group with bending of the knee, 30.69% in the group with a sports injury, whereas the percentage of subjects experiencing pain while ascending stairs was 34.09% in the group with a fall, 47.73% in the group with bending of the knee and 18.18% in the group with a sports injury. All three subjects experiencing pain while descending stairs suffered a trauma to the knee due to a fall, while one patient complained about a locking of the knee as a result of a fall, 5 as a result of bending and 4 as a result of a sport activity.

The cause of trauma did not play a significant role in the localization of the pain ($p=0.26$). Lateral and medial localization of the pain was most common in participants after a fall (29.41%, 39.02% respectively), whereas anterior and posterior localization of pain was experienced primarily in subjects who experience a trauma due to a bending of the knee (48.72%, 46.15% respectively).

The difference between the three groups of patients with different causes of trauma was statistically insignificant in relation to the intensity of pain ($p=0.38$). In the groups with weak as well as strong pain, the most common cause of the trauma was bending of the knee (46.35% and 42.86% respectively), whereas patients which reported moderate pain most commonly acquired the trauma as a result of a fall (35.78%). The differences that exist in the described distribution are insufficient in proving statistical significance.

In the group consistent of athletes, 18.68% sustained the trauma as a result of a fall, 13.19% as a result of a bending of the knee.

In the group of patients which are not athletes, 39.41% sustained the injury as a result of a fall, 53.71% as a result of a bending of the knee and only 5.88% while participating in sports activities. These results were also proved statistically, athletes and non-athletes differ statistically in the manner in which they sustained a trauma to the knee ($p<0.001$).

Fluid in the knee was detected in 34.83% of patients which reported a fall as the cause of trauma, 31.46% from the group reporting a bending in the knee and 33.71% from the group sports injury. Findings of fluid in the knee did not significantly depend on the cause of trauma ($p=0.094$).

Bone oedema seen in MRI of the traumatized knee most usually goes with lesions of the cartilage, meniscus and anterior cruciate ligament (Bretlau, et al. 2002; Paakkala, et al. 2010, Youn, et al. 2011) where a lesion on the anterior cruciate ligament occurred in 80% of cases with lesion on the meniscus, cartilage and oedema.

In our study with regard to the complexity of the trauma to the knee, the results showed that in 119 (45.59%) of the

subjects the trauma was isolated, in the remaining 142 (54.41%) subjects the trauma was complex.

5. Conclusion

Age and body weight do not have an impact on the cause of trauma and the type and grade of the lesions of the knee. Females tend to injure the knee more frequently as a result of a fall whereas males as a result of a bending of the knee. Males are more prone to sports traumas.

Localization of the pain is not linked to the cause of injury it depends on the developed lesion on the knee.

The intensity of pain does not depend on the cause of injury it is subjective to the category and the pain threshold is different in each patient.

Athletes and subjects who are not athletes have significantly different causes of trauma to the knee.

With athletes bending of the knee is most common, whereas in non-athletes it is fall.

Findings of knee fluids do not significantly depend on the cause of injury.

The statistical analysis confirmed that patients with lesions in the posterior horn of the medial meniscus grade 3 had significantly more bone oedemas ($p=0.013$).

All patients with a combined trauma to the anterior cruciate ligament and the posterior horn of the medial meniscus had a bone oedema Type 1 and Type 2. Bone oedemas should always be searched during an MRI analysis of the knee as it can lead to finding the lesion.

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