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FEMORAL MALTORSION INFLUENCES BOTH PATELLOFEMORAL AND TIBIOFEMORAL CONTACT PRESSURE. A BIOMECHANICAL EVALUATION

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INTRODUCTION

Pathogenesis of knee osteoarthritis (KOA) in the young patient is predominantly related to an unfavorable biomechanical environment at the joint.
A deformity in the coronal plane will cause excessive stress on the knee joint that will cause damage to the articular cartilage. However, the connection between femoral maltorsion (FM) and KOA is less studied.

HYPOTHESIS AND OBJECTIVE:

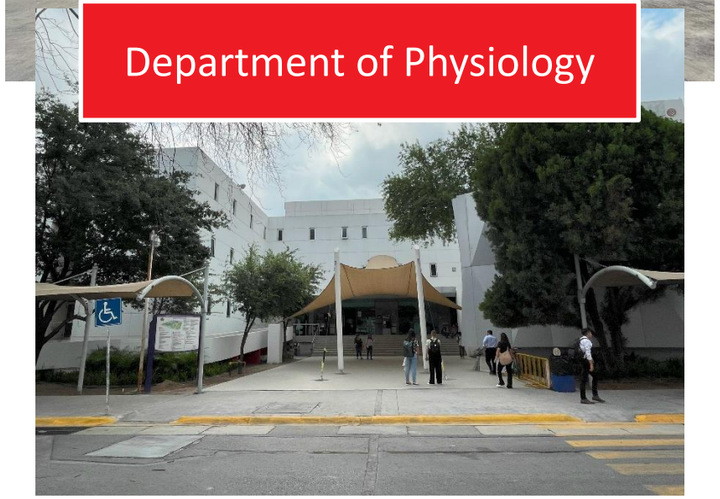
- ✓ **Hypothesis** : there is a correlation between FM and intra-articular knee pressures, with consequent abnormal loading of the articular cartilage.

- ✓ **Objective:** to investigate the effect of femoral torsion on patellofemoral and tibiofemoral contact pressures to study the etiopathogenesis of knee osteoarthritis in young adults.

MATERIALS AND METHODS: Study design

School of Medicine, Universidad de Monterrey, Mexico

Department of Physiology



Exclusion criteria:

- Osteoarthritis
- Trauma
- Previous surgeries
- Malalignment

✓ Experimental biomechanical study

✓ 10 human cadaver knees

✓ **Average age: 40.2 years ± 9.5**

✓ 8 male and 2 females specimens(6 Right and 4 Left)

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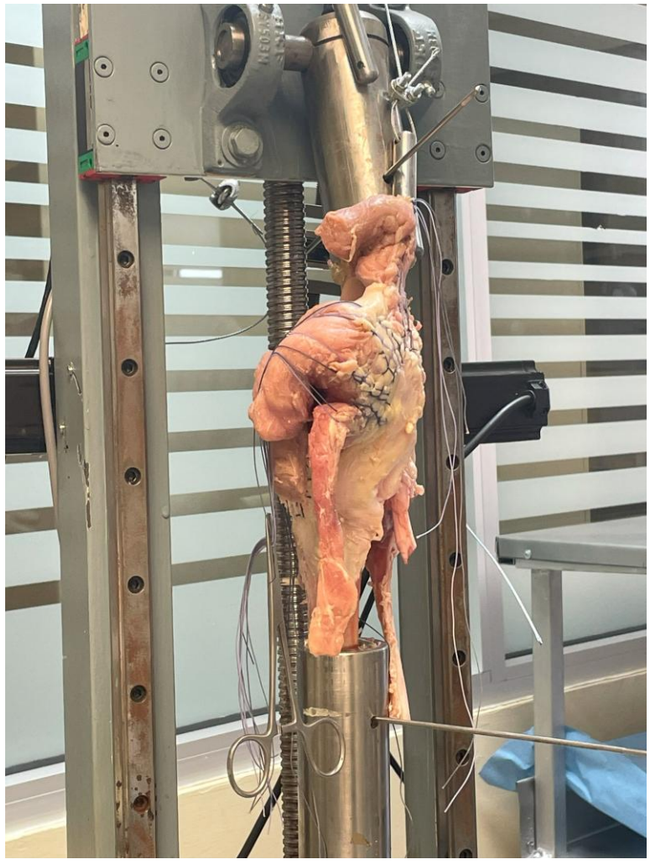
MATERIAL AND METHODS: Specimen preparation



Removal of skin and subcutaneous tissue → Preserved tissues:
- Muscle groups
- Cruciate ligament
- Lateral and medial colateral ligament
- Extensor apparatus

Krackow sutures :
- Vastus medialis obliquus (VMO)
- Vastus lateralis (VL)
- Rectus femoris (RF)
- Vastus intermedius (RFVI)

→ 3 quadriceps vectors

Krackow suture:
- Hamstrings

→ Independent hamstring vector

MATERIAL AND METHOD: Load simulation

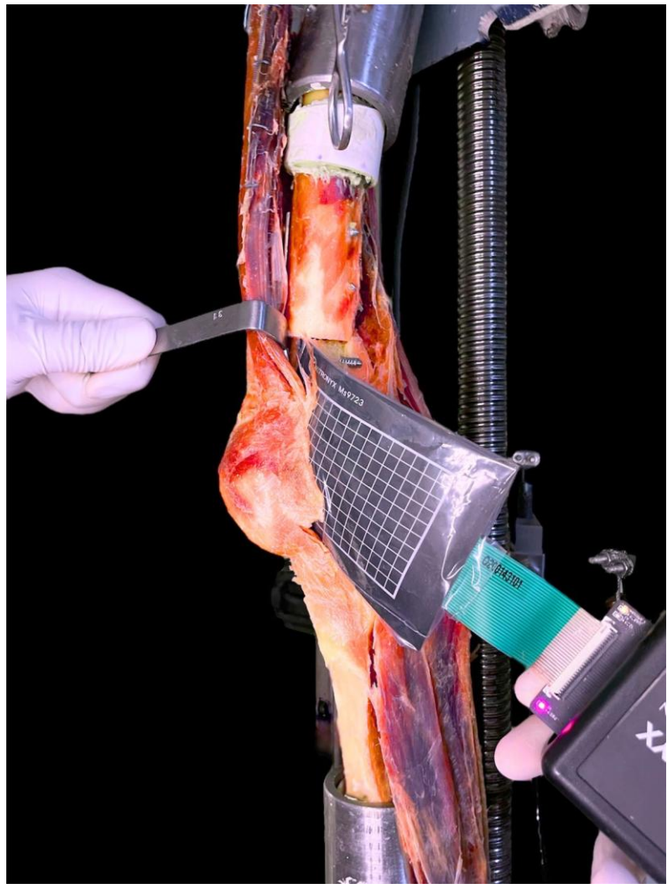
Quadriceps directions:
- VL 20° lateral
- RF + VI 5° anterior
- VMO 35° medial

Loads:
- VL 76 N
- RFVI 87 N
- VMO 55 N
- Hamstrings 80 N

AXIAL LOAD: 1000 N distal tibia

2 TESTS FOR EACH CONDITIONS:
- Native knee
- Internal femoral rotation (IFR) 10º
- Internal femoral rotation (IFR) 20º
- Internal femoral rotation (IFR) 30º
- External femoral rotation (EFR) 10º
- External femoral rotation (EFR) 20º
- External femoral rotation (EFR) 30º.

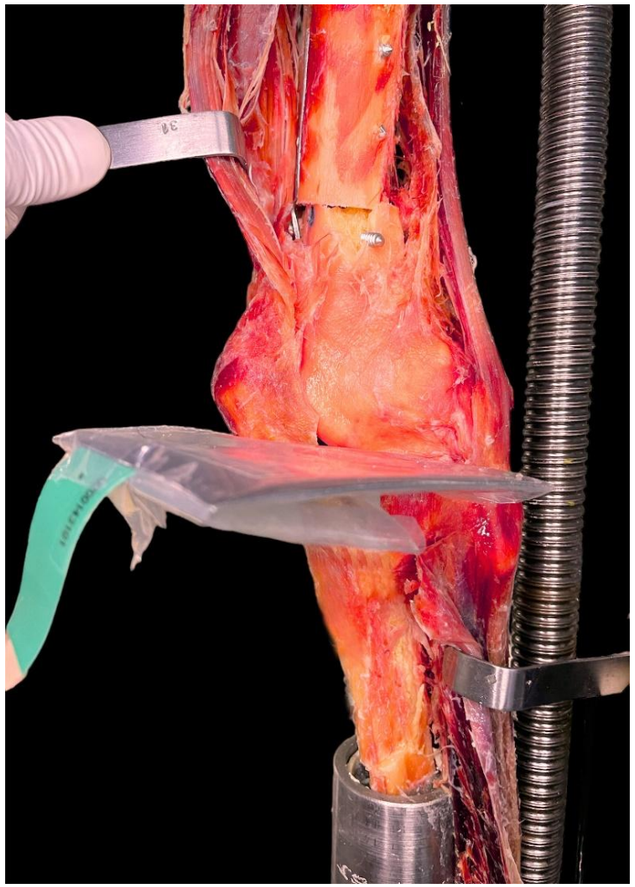
MATERIAL AND METHOD: Patellofemoral and tibiofemoral pressure



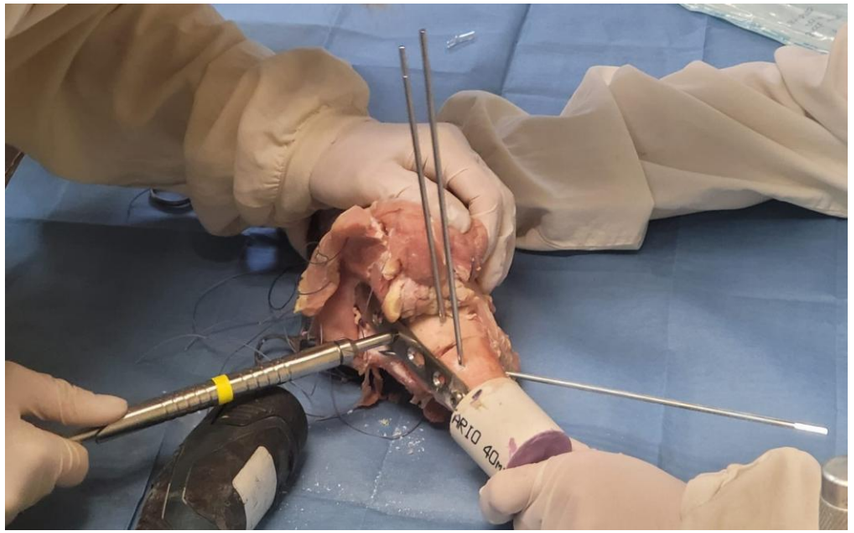
Sensor 77,3 x 77,3 mm SFM6000CXR2 (Kitronyx Inc®)

Controller Baikal II (Kitronyx Inc®)

Interpretation software Snowforce 3 (Kitronyx Inc®)



MATERIALS AND METHODS: Performance of the osteotomy



Longitudinal incision of the iliotibial band and the vastus lateralis separated by blunt dissection from the fascia lata

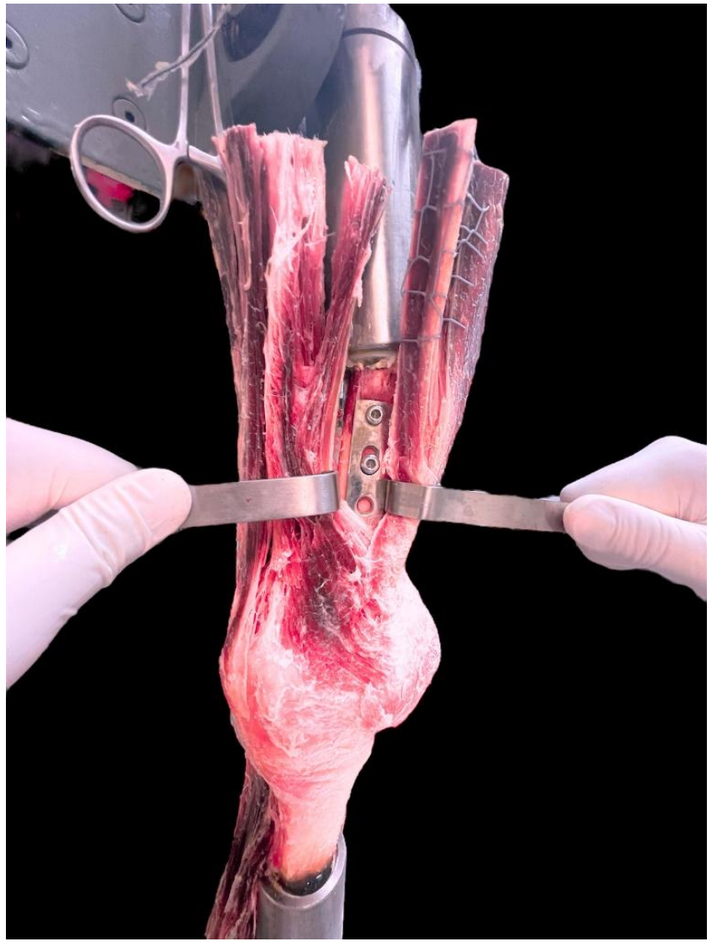
The site of supracondylar femoral osteotomy was defined under fluoroscopic guide (perpendicular to the anatomical axis of the femoral diaphysis)

2 parallel threaded KW, one proximal and the other distal to the osteotomy site.

Osteotomy was performed using an oscillating saw of 0.6 mm diameter

The distal fragment rotated until the desired angle of rotation (10°, 20° ,30° of internal rotation of the distal fragment, as well as 10°, 20°,30° of external rotation of the distal fragment) was reached with the distal K-wire.

MATERIALS AND METHODS: performance of the osteotomy.



Angulations were confirmed using a digital goniometer

The osteotomy was fixed using a non-locking plating system, employing a lateral and medial plate to obtain absolute stability of the osteotomy site

3 fixation screws were placed for the distal fragment and 4 screws for the proximal fragment

Pressure measurements were again made in each knee compartment, , at each of the degrees of rotation evaluated

RESULTS: TIBIOFEMORAL PRESSURE

Pressure (MPa)	Flexión 0°	Flexión 30°	Flexión 60°	Flexión 90°	P
Control	1.033 ± 0.01880	1.042 ± 0.01924	1.048 ± 0.01912	1.056 ± 0.02094	<0.0001
EFR 10°	1.346 ± 0.03246	1.356 ± 0.03468	1.363 ± 0.03529	1.373 ± 0.03640	<0.0001
EFR 20°	1.540 ± 0.03059	1.549 ± 0.02902	1.560 ± 0.03059	1.570 ± 0.03040	<0.0001
EFR 30°	1.608 ± 0.01816	1.618 ± 0.01733	1.628 ± 0.01646	**1.636 ± 0.01878**	<0.0001
IFR 10°	1.163 ± 0.01721	1.173 ± 0.01801	1.186 ± 0.01914	1.197 ± 0.01638	<0.0001
IFR 20°	1.087 ± 0.04478	1.117 (0.034)	1.144 ± 0.01884	1.157 ± 0.02302	<0.0001
IFR 30°	1.047 ± 0.03077	1.081 ± 0.02480	1.107 ± 0.02230	1.110 (0.031)	<0.0001
P	<0.0001	<0.0001	<0.0001	<0.0001	

MEDIAL

Pressure (MPa)	Flexión 0°	Flexión 30°	Flexión 60°	Flexión 90°	P
Control	0.9789 ± 0.03813	1.003 ± 0.01754	1.013 ± 0.01492	1.020 ± 0.01283	0.0184
EFR 10°	1.112 ± 0.01156	1.124 ± 0.009130	1.134 ± 0.008643	1.144 ± 0.008043	<0.0001
EFR 20°	1.068 (0.038)	1.104 ± 0.006896	1.116 ± 0.006949	1.128 ± 0.008036	<0.0001
EFR 30°	0.9925 ± 0.03755	1.035 ± 0.01918	1.058 ± 0.02296	1.079 ± 0.02061	<0.0001
IFR 10°	1.112 ± 0.01544	1.124 ± 0.009881	1.135 ± 0.008709	1.147 ± 0.008242	<0.0001
IFR 20°	1.303 ± 0.01242	1.316 ± 0.01165	1.328 ± 0.01200	1.341 ± 0.01077	<0.0001
IFR 30°	1.398 ± 0.01004	1.411 ± 0.008141	1.423 ± 0.007344	**1.432 ± 0.004051**	<0.0001
P	<0.0001	<0.0001	<0.0001	<0.0001	

LATERAL

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RESULTS: PATELLOFEMORAL PRESSURE

Pressure (MPa)	Flexión 0°	Flexión 30°	Flexión 60°	Flexión 90°	P
Control	0.8296 ± 0.2036	1.403 ± 0.2279	1.233 ± 0.1945	1.140 ± 0.1174	<0.0001
EFR 10°	1.258 ± 0.06754	1.730 ± 0.1471	1.359 ± 0.1693	1.226 ± 0.1066	<0.0001
EFR 20°	1.329 ± 0.07345	1.952 ± 0.1333	1.542 ± 0.1331	1.251 (0.242)	<0.0001
EFR 30°	1.437 ± 0.1055	**2.140 ± 0.1832**	1.713 (0.181)	1.374 ± 0.1124	0.0004
IFR 10°	1.186 ± 0.04490	1.655 ± 0.08713	1.396 ± 0.1001	1.183 ± 0.04037	<0.0001
IFR 20°	1.238 ± 0.04783	1.773 ± 0.09088	1.447 ± 0.1469	1.242 ± 0.09576	<0.0001
IFR 30°	1.335 ± 0.1297	1.878 ± 0.1230	1.587 ± 0.09653	1.295 ± 0.1107	<0.0001
P	<0.0001	<0.0001	<0.0001	0.0006	

MEDIAL

Pressure (MPa)	Flexión 0°	Flexión 30°	Flexión 60°	Flexión 90°	P
Control	1.049 ± 0.08994	1.278 ± 0.08453	1.178 ± 0.07892	1.102 ± 0.07857	<0.0001
EFR 10°	1.096 ± 0.05519	1.268 ± 0.1013	1.186 ± 0.07241	1.124 ± 0.05994	<0.0001
EFR 20°	1.129 ± 0.06866	1.301 ± 0.07977	1.203 ± 0.06883	1.149 (0.121)	0.0008
EFR 30°	1.135 ± 0.05609	1.328 ± 0.07630	1.231 ± 0.06460	1.162 (0.114)	0.0014
IFR 10°	1.124 ± 0.05903	1.299 ± 0.07842	1.196 ± 0.06807	1.136 ± 0.05126	0.0003
IFR 20°	1.145 ± 0.06854	1.327 ± 0.06760	1.232 ± 0.07526	1.144 ± 0.01934	<0.0001
IFR 30°	1.158 ± 0.06544	**1.352 ± 0.08166**	1.235 ± 0.08159	1.153 (0.054)	0.0002
P	0.0029	0.0059	0.0110	<0.0001	

LATERAL

RESULTS

TIBIOFEMORAL

- Pressure increase from 10° to 30° of RFI
- Pressure increase with knee flexion from 0° to 90°. **Strongest effect: 90° of flexion (P<0.0001) and at 30° of IFR (P<0.0001)**.
- **TIBIOFEMORAL PRESSURE IS LESS IMPAIRED IN DAILY LIFE ACTIVITIES**

PATELLOFEMORAL

- Increased PF pressure on the ***opposite facet*** of the patella with respect to torsion.
- *Lateral aspect* of patella: increased pressure with progressive IFR. **Stronger effect at 30° of knee flexion (P=0.0059) with 30° of IFR (P= 0.0002).**
- *Medial aspect* of the patella: increased pressure with progressive RFE. **Strongest effect: 30° of knee flexion (p=0.005) with 30° of EFR (p=0.004)**
- **PATELLOFEMORAL PRESSURE IS MORE SENSITIVE TO EFR THAN TO IFR**

CONCLUSION

- The pathogenesis of KOA in the young patient is related to an unfavorable biomechanical environment at the joint
- Both FP and FT pressures are sensitive to femoral torsion.
- The greatest overload of the PF joint occurs at 30° of knee flexion with both 30° EFR and 30° IFR.
- The greatest overloads of the TF joint occur at 90° of knee flexion and 30° of EFR.
- In patients with severe femoral malrotation the PF joint is damaged more in activities of daily living than the TF joint.
- There is more tolerance in the knee to IFR (anteversion) than to EFR (retroversion).

BIBLIOGRAPHY

1) Van Rossom S, Wesseling M, Smith CR, et al.(2019)The influence of knee joint geometry and alignment on the tibiofemoral load distribution:A computational study. Knee.;26(4):813-823

2) Huang W, Zeng X, Man GC, Yang L, Zhang Y. (2022). Simultaneous Measurement of Patellofemoral Joint Kinematics and Contact Mechanics in Intact Knees: A Cadaveric Study. Orthop Surg. 14(9):2317-2329

3) McCulloch PC, Dolce D, Jones HL, Gale A, Hogen MG, Alder J, Palmer JE, Noble PC (2016) Comparison of Kinematics and Tibiofemoral Contact Pressures for Native and Transplanted Lateral Menisci. Orthop J Sports Med 4(12):2325967116674441

4) Besier TF, Gold GE, Delp SL, Fredericson M, Beaupré GS. The influence of femoral internal and external rotation on cartilage stresses within the patellofemoral joint. Journal of Orthopaedic Research®. 2008;26(12):1627-1635

5) Kenawey M, Liodakis E, Krettek C, Ostermeier S, Horn T, Hankemeier S. Effect of the lower limb rotational alignment on tibiofemoral contact pressure. Knee Surgery Sports Traumatology Arthroscopy. 2011;19(11):1851-1859

6) 23. Lee TQ, Anzel SH, Bennett KA, Pang D, Kim WC. (1994) The Influence of Fixed Rotational Deformities of the Femur on the Patellofemoral Contact Pressures in Human Cadaver Knees. CLINICAL ORTHOPAEDICS AND RELATED RESEARCH.; 302:69–74