Martin-Luther-Krankenhaus
Ein Unternehmen der Paul Gerhardt Diakonie

The dead meniscus sign: No dynamic extrusion in medial meniscus root lesions – an ultrasound study

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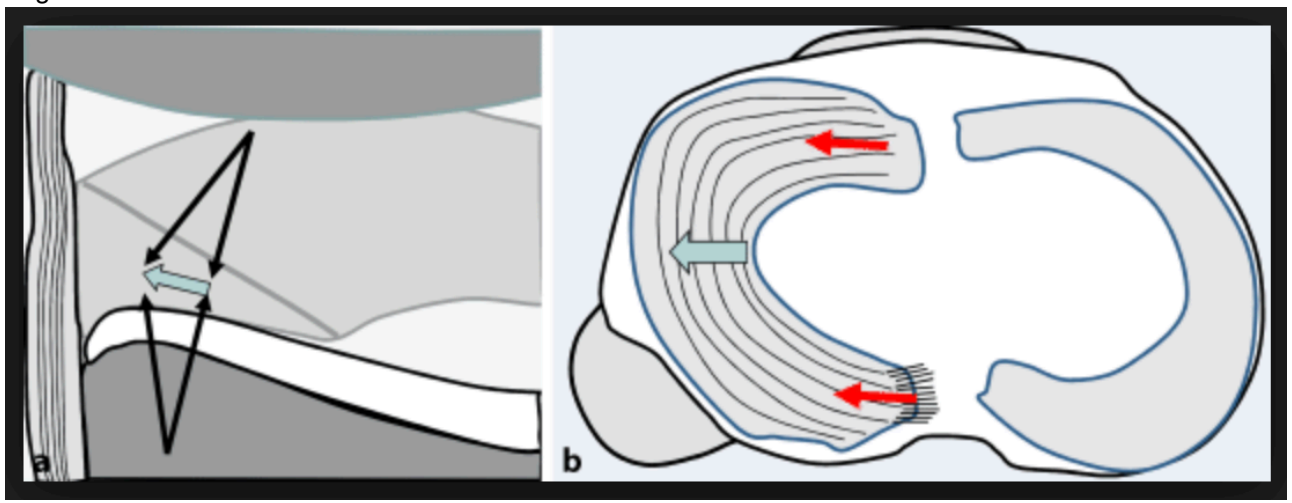
Introduction - Biomechanics

Fig.1

Fig.2



The wedge-shaped menisci improve the congruity of femur and tibia and provide uniform distribution of load across the articular surface (*Fig.1*). For this function, the roots of the menisci play an important role. The normal forces acting on the meniscus tend to extrude the menisci radially (*Fig.2a,b*). The menisci cannot extrude radially because the four chondral insertion zones firmly attach the menisci to the tibial intercondylar region. By this mechanism, the radially acting normal forces are transmitted in a circular hoop stress which is transferred to the insertions of the menisci.

Introduction – Root Tear

Fig.3

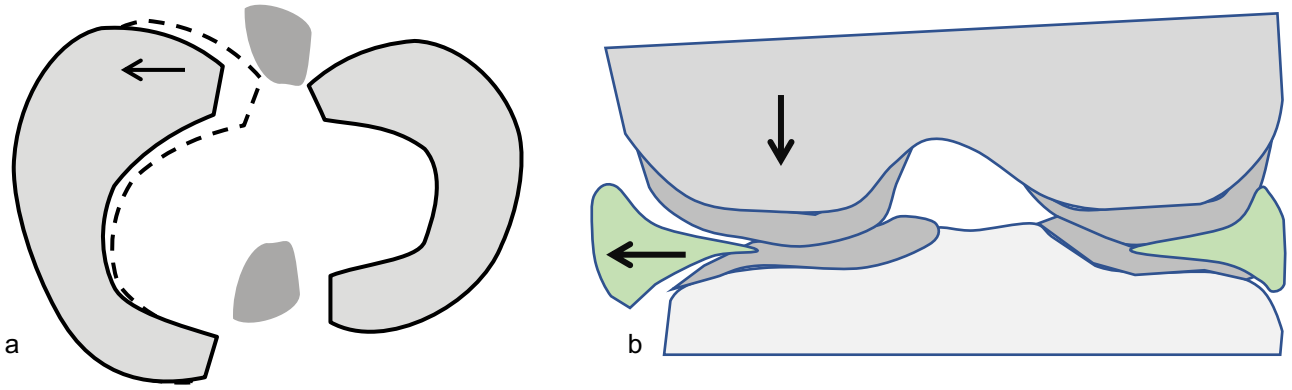
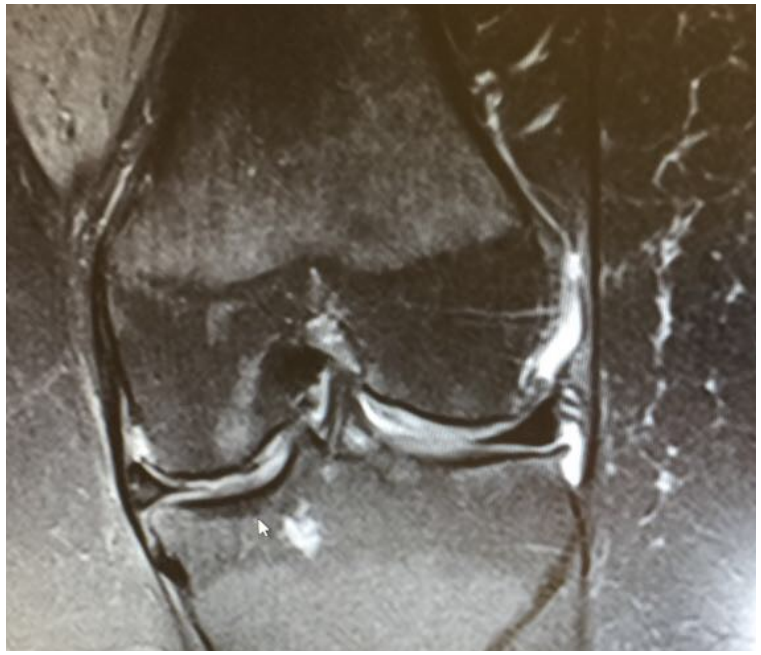


Fig.4



A root tear is a complete radial lesion typically occurring at the posterior insertion zone of the meniscus. This lesion interrupts the circular hoop tension and leads to extrusion of the meniscus (*Fig.3a,b*). Radial extrusion of the meniscus is considered to be the cause for a decrease in tibiofemoral contact area and increase in peak pressure. Meniscus extrusion is a typical finding in MRI of patients with medial root tears extending beyond the tibial margin (*Fig.4*).

Introduction – Dynamic Extrusion

Fig.5

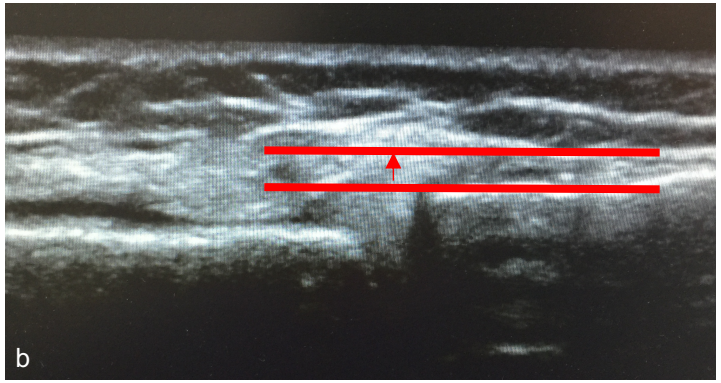
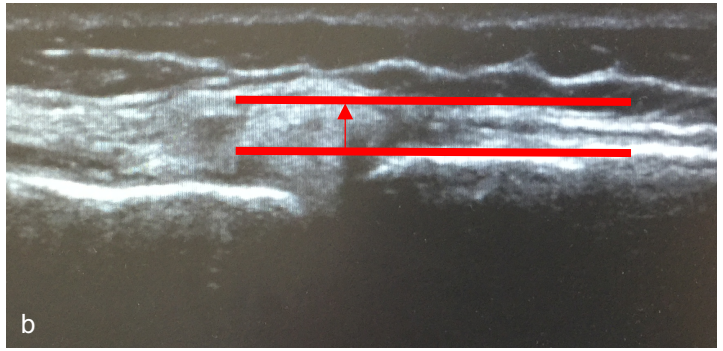


Fig.6



It was demonstrated that meniscus extrusion can also be reliably detected with ultrasound but is probably not always a pathological finding. In knees of healthy volunteers a mean meniscus extrusion increased from 1.1mm in supine position *(Fig.5a,b)* to 1.9mm in standing position *(Fig.6a,b).* The difference was described as dynamic extrusion. An explanation for this phenomenon can be seen in the viscoelasticity of the meniscal tissue which means axial load causes a temporal limited, reversible deformation. Therefore, not just an absolute increased meniscus extrusion might be indicative for a malfunction, but rather an increased or absent functional adaption reaction.

Hypothesis

Aim of the present study was to examine dynamic meniscus extrusion in knees of patients with confirmed **medial root tear** and in healthy knees as a control group. Based on the findings of previous MRI studies it is hypothesized that patients with a medial meniscus root tear will demonstrate increased meniscus extrusion in the supine and standing position but a **smaller dynamic meniscus extrusion with ultrasound**.

Methods

25 patients with medial root tear on MRI (*patients*) were enrolled in this prospective study as well as 25 age matched healthy volunteers (*control*).

Inclusion criteria: age > 18 years and the radiological proof of a medial meniscus root lesion on MRI *(Fig.7).*

Exclusion criteria: osteoarthritis, severe long leg axis deformity, diagnosed meniscus lesion > Stoller III, cruciate ligament lesion.

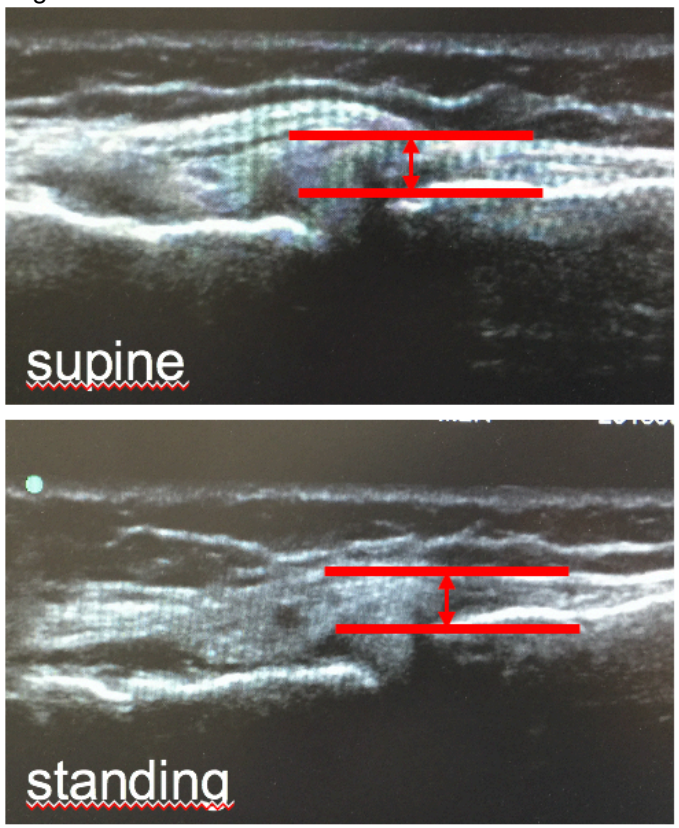
Fig.7

The ghost sign, also known as empty meniscus sign, was chosen as radiological criteria for a root lesion because it indicates a complete disruption of the circular meniscus fibers.

Methods

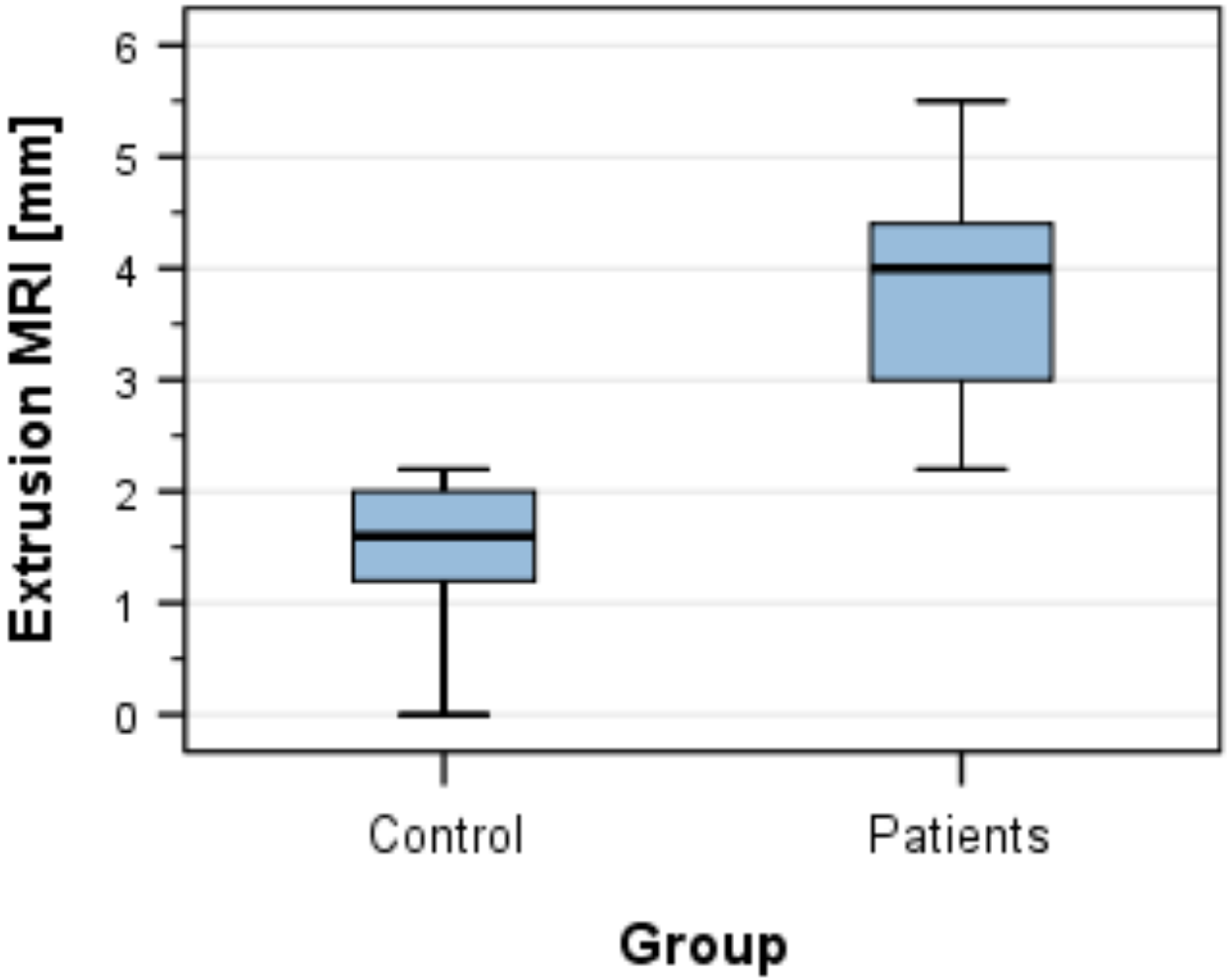
The extrusion of the medial meniscus on the affected knee was measured on MRI as well as by ultrasound in the supine and standing position. Extrusion was defined as the distance between a tangent line parallel to the fiber orientation of the MCL at the margin of the medial tibial cortex and the outermost edge of the medial meniscus *(Fig.8)*.

Fig.8



Results - MRI

Medial static meniscus extrusion

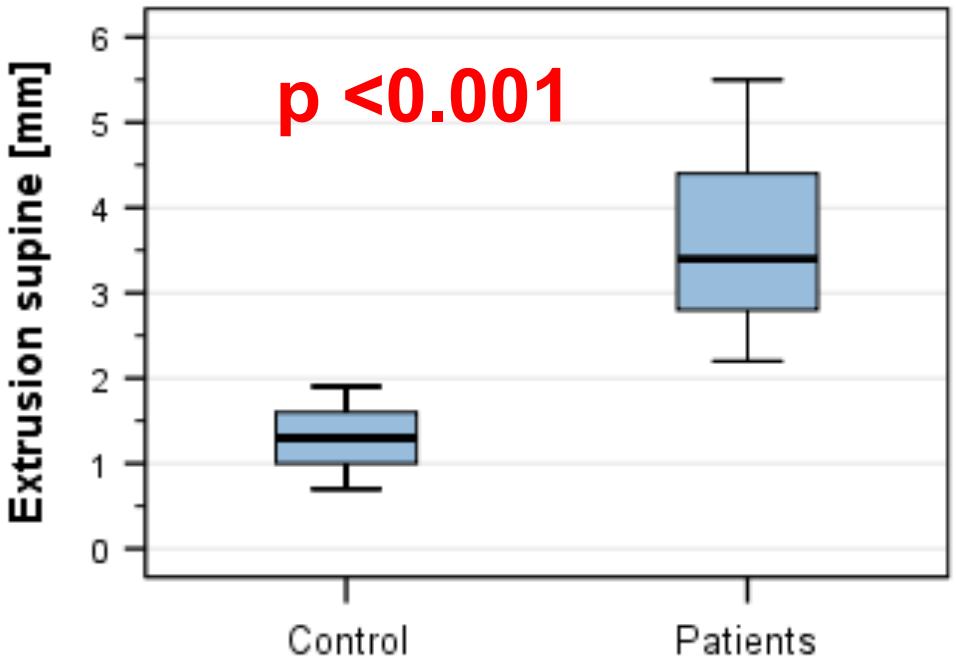


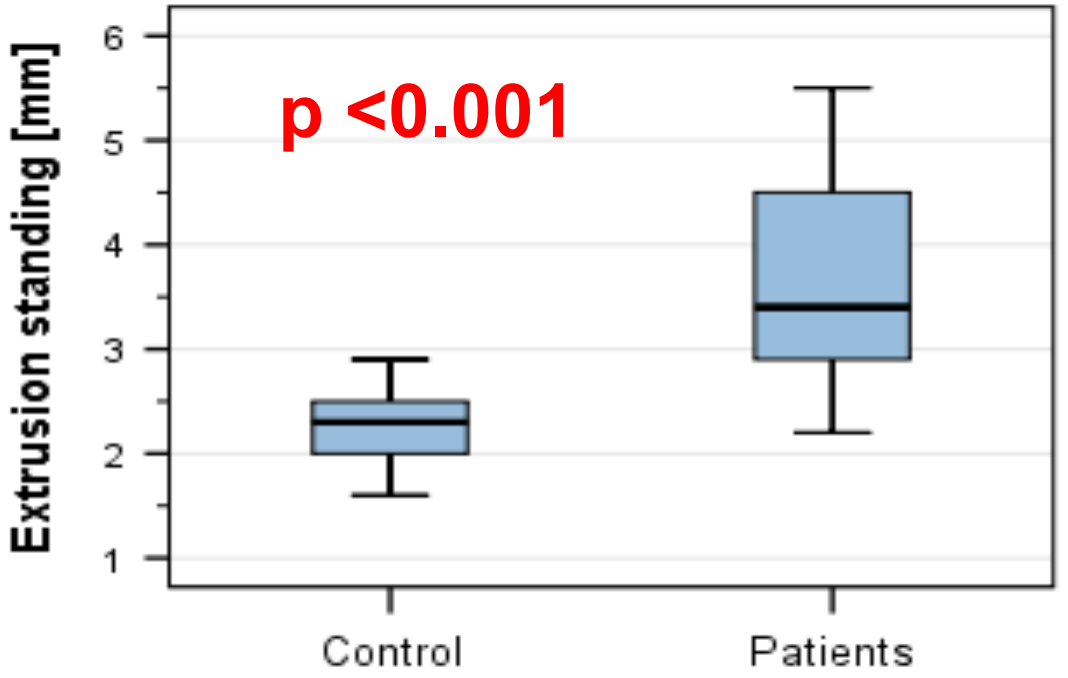
- Control: **1.43 mm** (± 0.65mm)
- Patients: **3.9 mm** (± 0.9 mm)

p <0.001

Results - Ultrasound

Medial dynamic extrusion in supine and standing position

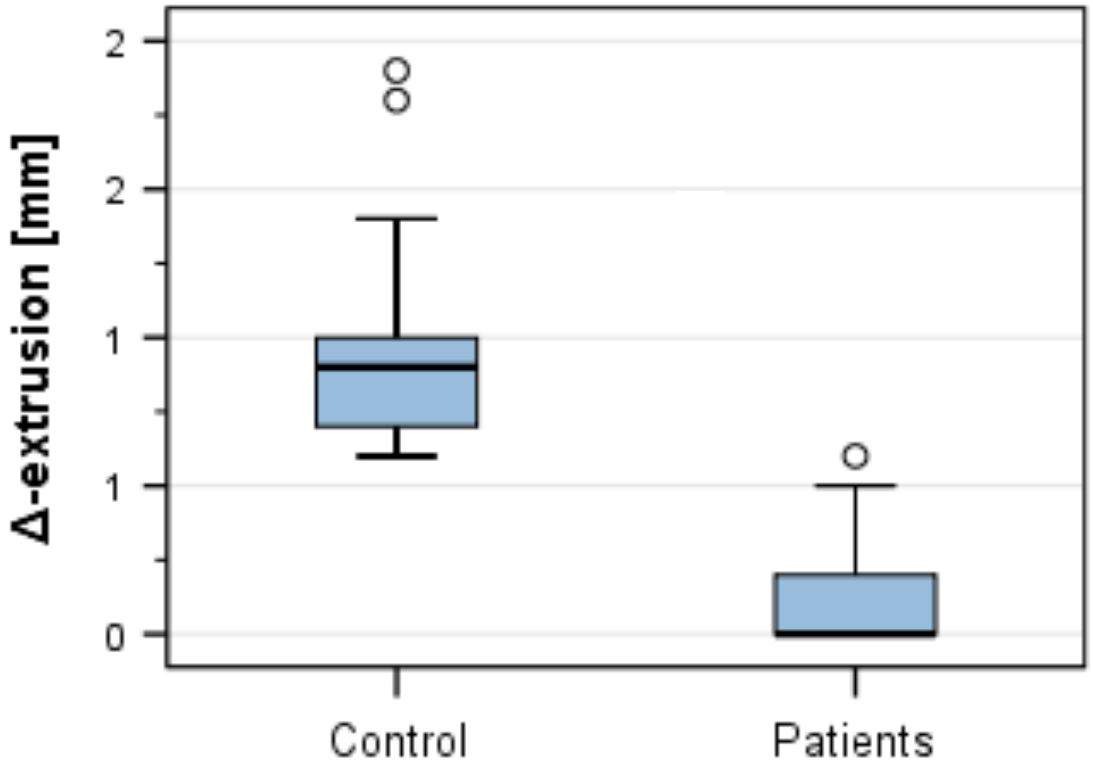




	Supine	Standing
Control	**1.31 mm** (± 0.34 mm)	**2.28 mm** (± 0.39 mm)
Patients	**3.63 mm** (± 0.96 mm)	**3.74 mm** (± 0.92 mm)

Results – Ultrasound

Medial delta dynamic extrusion



➡ Control: **0.95 mm** (± 0.36 mm)

➡ Patients: **0.11 mm** (± 0.16 mm)

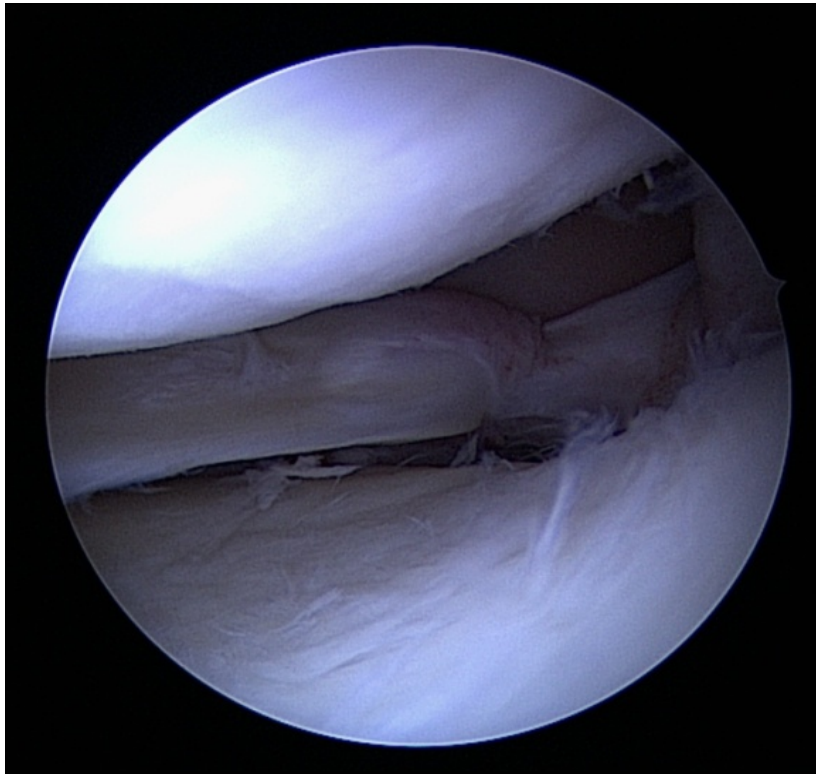
p <0.001

Conclusion

The present study demonstrates that **medial root tear of the meniscus** *(Fig.9)* leads to **significant decreased dynamic medial displacement** compared to heathy meniscus status. Therefore, lack of dynamic meniscus extrusion may serve as an indicator for medial root injury and could be easily detected via ultrasound examination.

As a term for this sign we suggest **"dead meniscus sign"**.

Fig.9



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