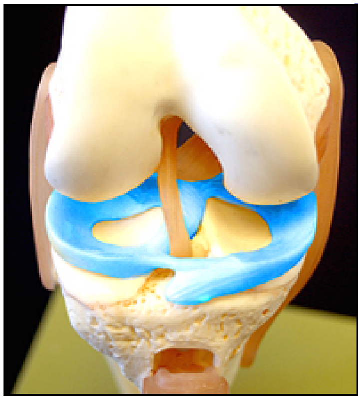


2012 Meniscus Transplantation Study Group

Tuesday, February 7, 2012 1:00 – 3:30 PM

W Hotel, Industry Room

181 Third Street, San Francisco, CA 94103

At the 2012 AAOS Annual Meeting

Meeting Agenda:

INTRODUCTION:

CDR Matthew T. Provencher, MD, MC, USN — ***1:00 – 1:10***
Biomechanical Evaluation of a High Tibial Osteotomy with a Meniscal Transplant — ***2 min discussion***

Kevin R. Stone, MD, Chairman — ***1:13 – 1:23***
<Title> — ***2 min discussion***

PRESENTATIONS:

A pilot study of the use of a polycarbonate-urethane implant (NUsurface®) for the treatment of postmeniscectomy medial knee pain — ***1:26 – 1:36***, ***5 min discussion***
Presented by Peter Verdonk, MD, PhD

Poly-urethane scaffold for the treatment of medial and lateral partial meniscus defects: A single center experience with focus on scaffold integrity — ***1:42 – 1:52***, ***5 min discussion***
Presented by Peter Verdonk, MD, PhD

Meniscal regeneration by a new polyurethane scaffold. A 2-year minimum follow-up study — ***1:58 – 2:08***, ***5 min discussion***
Presented by Stefano Zaffagnini, MD

Arthroscopic single tibial tunnel meniscal allograft transplantation without bone plugs. A 3-year minimum follow-up study — ***2:14 – 2:24***, ***5 min discussion***
Presented by G.M. Marcheggiani Muccioli, MD

Lyophilised medial meniscus transplantations in ACL-deficient knees: a 19-year follow-up — ***2:30 – 2:40***, ***5 min discussion***
Presented by Burak Akan

Releasing the circumferential fixation of the medial meniscus does not influence its kinematics — ***2:46 – 2:56***, ***5 min discussion***
Presented by Anne Vrancken, MSc

The effect of arthroscopic partial medial meniscectomy on tibiofemoral position and stability — ***3:02 – 3:12***, ***5 min discussion***
Presented by Sally Arno, MSc

MRI of Meniscal Transplantation — ***3:18 – 3:28***, ***5 min discussion***
Presented by John Crues, MD

Biomechanical evaluation of a high tibial osteotomy with a meniscal transplant

GS Van Thiel[1], RM Frank[1], A Gupta[3], N Ghodadra1, EF Shewman[3], VM Wang[2], BR Bach[1], NN Verma[4], BJ Cole[1], MT Provencher[1]

[1]Division of Sports Medicine, Department of Orthopedics, University of Illinois, Chicago, Illinois, [2]Sports Research Laboratory, Rush University Medical Center, Chicago, Illinois, [3]Department of Biomechanics, University of Illinois, Chicago, Illinois, [4]Department of Orthopaedic Surgery, Naval Medical Center San Diego, San Diego, California

This study determines the biomechanical advantage and the optimal configuration of a high tibial osteotomy (HTO) and meniscus transplantation performed concurrently. Six cadaver knees were placed in a spatial frame, and an HTO was completed. Loading points between a mechanical 6 degrees of varus and 8 degrees of valgus were loaded to 800 N for medial meniscal intact, meniscectomized, and transplanted states. Posterior slope was also increased by 3 degrees in these specimens. Contact data was recorded. Peak pressures significantly increased in the meniscectomized state in every degree of varus/valgus ($p < 0.05$). For both peak and total medial compartment pressures, there was a significant drop ($p < 0.001$) between neutral and 3 degrees of valgus. Lateral compartment pressures linearly increased from varus to valgus orientation. There was no significant change in the pressure profile of the knee with a 3-degree increase in posterior slope. This biomechanical study confirms the hypothesis that an HTO improves the peak pressures in the medial compartment at all degrees of varus/valgus alignment in the setting of meniscal transplantation. Furthermore, the largest decrease in medial pressures was between neutral and 3 degrees of valgus, suggesting that perhaps neutral aligned knees could benefit from an HTO.

Releasing the circumferential fixation of the medial meniscus does not influence its kinematics

ACT Vrancken [1], TG van Tienen [1,2], BL Fransen [1], D Janssen [1], N Verdonschot [1,3], P Buma [1]

[1]Orthopaedic Research Lab, Radboud University Nijmegen Medical Centre, The Netherlands; [2]Via Sana Clinic, The Netherlands; [3]Department of Biomechanical Engineering, University of Twente, The Netherlands

Introduction

The menisci are crucial in load transmission and stability of the knee joint. Both horns of the medial meniscus (MM) are connected to the tibia plateau, while its outer circumference is integrated with the knee capsule and the medial collateral ligament. It is unknown whether this medial fixation contributes to natural MM motion, while this may have important implications for the fixation strategy of meniscus replacements, either allografts or implants. Therefore, the current study investigates whether MM kinematics is influenced when its circumferential fixation condition is changed.

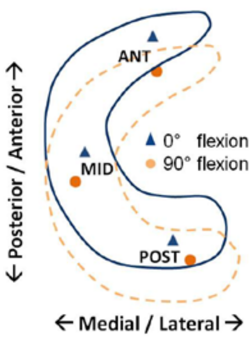


Figure 1: Bead locations (ANT-MID-POST) and an example of MM motion between 0°-90° flexion

Methods

5 right human cadaveric knees (3 female, 2 male, 82±8 years) with intact menisci were loaded in a knee loading rig, with 6 DOF's for the tibia with respect to the femur [van Tienen, 2005]. The knees were flexed from 0° to 90° with 30° increments. A compressive load (357-1000N, increasing with flexion angle) was applied the tibia. Knees were first positioned in neutral orientation, after which an internal (5Nm) and an external moment (2Nm) were applied. Radiopaque beads were fixed in the MM anterior, posterior and mid-region (Fig 1). Medio-lateral (ML) and anterior-posterior (AP) translations between 0° and 90° flexion were calculated from the bead locations using röntgen stereophotogrammetric analysis. Measurements were repeated for 3 conditions: (I) intact fixation, (II) detached fixation and (III) resutured fixation.

Results

A representative example of MM motion is visualised in Figure 1. Mean ML and AP translations in neutral orientation are shown in Figure 2, upper row. Due to femoral rollback, a posterior shift was seen in all regions. The meniscus furthermore deformed with increasing flexion angle, noticeable from the displacement differences between the regions. Application of an internal or external moment did not significantly alter the translations for any of the fixation options. The differences between the fixation conditions were small and non-significant (Fig. 2, lower row).

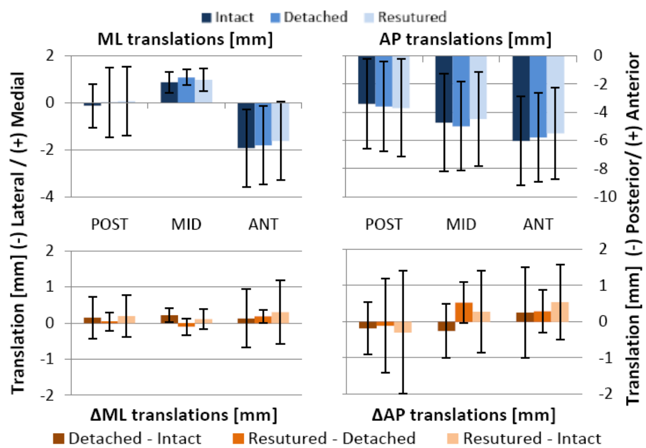


Figure 2: MM translations (blue) and differences in translations (orange) for intact, detached and resutured circumferential fixation (mean ± SD)

Discussion

Releasing and restoring circumferential fixation of the MM does not seem to influence meniscus kinematics. For knee flexion up to 45° it has been shown that a MM autograft without circumferential fixation results in better contact mechanics than an autograft sutured to the knee capsule [Alhalki, 1999]. Therefore, before recommendations regarding meniscal replacement fixation strategies may be given, it is essential to analyse contact mechanics data, which also has been collected.

References

Alhalki *et al*, Am J Sports Med, 27:320-328, 1999
van Tienen *et al*, KSSTA, 13:287-292, 2005

Acknowledgements

This research forms part of the Project P2.03 TRAMMPOLIN of the research program of the BioMedical Materials institute, co-funded by the Dutch Ministry of Economic Affairs, Agriculture and Innovation. Support was also provided by the Dutch Arthritis Foundation (Project LLP-15).

Meniscal regeneration by a new polyurethane scaffold. a 2-year minimum follow-up study

S Zaffagnini[1*], E Kon[1], GM Marcheggiani Muccioli[1], G Filardo[1], M Busacca[2], M Marcacci[1]

[1]*University of Bologna,* [2]*Radiology and Diagnostic Imaging, Istituto Ortopedico Rizzoli, Bologna, Italy*

Objectives

The possibility to reproduce the meniscus structure and function is highly attractive, aiming to restore knee biomechanics and to prevent the development of early osteoarthritis. Regenerative approaches have been advocated to improve the reparative processes of joint tissues, and good results have already been reported in the literature at long-term[1]. Recently, a new polyurethane scaffold (ActifitTM,Orteq Ltd, UK) has been introduced in clinical practice claiming
better material properties to resist the high knee forces and therefore a better chondroprotection[2].

Methods

We performed a prospective clinical evaluation of 18 patients (11 males, 7 females, mean age 45 y) affected by a massive loss of meniscal substance either medial or lateral (13 and 5, respectively), associated with intra-articular or global knee pain and/or swelling, and treated with ActifitTM "all-inside" arthroscopic implantation. Nine patients also underwent associated procedures involving cartilage treatment or osteotomies. Patients were evaluated clinically and with Magnetic Resonance Imaging (MRI) up to 2 years of follow-up.

Figure 1. Actifit signal at 2-year follow-up.

Results

The evaluation of the patients who underwent Actifit implantation showed good results at short term follow-up, both from the clinical and imaging point of view. One patient had a reinjury playing competitive soccer after the 12 months evaluation and was excluded from the subsequent analysis. IKDC subjective score improved from 47,3±17,5 to 72,9±13,9 (p< 0,0005) at 1 year and 74,6±15,3 (p< 0,0005) at 2 years of follow-up, but an even higher improvement (77,7±15,7, p< 0,0005) was documented when analyzing patients without associated treatment of chondral lesions or osteotomy. MRI results were encouraging with a good cartilage preservation, even if the Actifit's signal was different from the one of native meniscus (Fig. 1).

Conclusions

Our results documented a significant clinical improvement treating partial meniscal lesions with scaffold implantation. Short term results after Actifit implantation are promising and similar to first generation scaffold, but long term randomized studies are needed to confirm if the better structural properties will lead also to better long-term clinical outcome and joint protection.

References

1. Zaffagnini S, et al. Am J Sports Med. 2011;39(5):977-85.
2. Verdonk R, et al. Am J Sports Med. 2011;39(4):774-82.

Artroscopic single tibial tunnel meniscal allograft transplantation without bone plugs A 3-year minimum follow-up study

GM Marcheggiani Muccioli, S Zaffagnini[1], A Grassi[1], T Bonanzinga[1], M Nitri[1], E Rimondi[2], M Busacca[2], M Marcacci[1]

[1]*University of Bologna*, [2]*Radiology and Diagnostic Imaging, Istituto Ortopedico Rizzoli, Bologna, Italy*

INTRODUCTION

Meniscal allograft transplantation is a viable option for sub/totally meniscectomized symptomatic patients and can potentially results in pain relief and increased function.

We hypothesized that the use of a single tibial tunnel arthroscopic meniscal allograft transplanation without bone plugs will reduce symptoms (pain) and improve knee function at minimum 3-year follow-up (FU) in previously meniscectomized patients.

METHODS

Thirty-two meniscal transplantation (16 medial, 16 lateral; 23 male, 9 female) were prospectively evaluated at minimum 36 months (mean 40.4±6.90, range 36-66) after surgery. Average age at surgery: 35.6±10.3 years (range 15- 55). The transplantation (Fig. 1) was performed using an arthroscopic bone plugs free technique with a single tibial tunnel plus “all-inside” meniscal sutures (Fig. 2). The anterior meniscal horn was sutured to the capsule. All patients underwent subjective and objective clinical evaluation, radiographs and MRI control of the involved knee before the surgery and at the final follow up. Magnetic Resonance Imaging (MRI) outcomes evaluation was performed by modified Yulish score[1].

RESULTS

Regarding clinical evaluation, there was a significant increase in scores at FU compared with preoperatively: VAS decreased from 70.6±21.7 to 25.2±22.7 ($P < .0001$), SF-36 for physical component increased from 37.31 ± 7.2 to 49.69 ± 8.3 ($P < .0001$), SF-36 for mental component increased from 49.69 ±10.8 to 53.53 ±7.5 ($P = .0032$), Tegner Activity increased from 3 (range 3-5) to 5 (range 3-6) ($P < .0121$), Lysholm increased from 59.78 ± 18.25 to 84.84 ± 14.4 ($P < .0001$), subjective IKDC increased from 47.44 ±20.60 to 77.20 ±15.57 ($P < .0001$) and objective IKDC changed from 1A, 21B, 6C, 4D to 22A, 9B, 1C ($P < .0001$). No significant difference was found between medial and lateral allograft or between outcomes of patient with isolated and combined procedures. MRI findings showed 69% of extruded allografts (25% medial, 44% lateral). In detail we found 50% of the medial allografts and 87% of the lateral allografts extruded. No significant difference in clinical outcome and modified Yulish score was found between patients with extruded allograft and with in-situ allograft. MRI shows also a significant decrease of modified Yulish score from baseline to 3-year minimum FU ($P < .0001$ for femur and $P < .0001$ for tibia). Only one patient underwent arthroscopic selective meniscectomy due to a medial posterior horn re-tear of the graft.

DISCUSSION

The results are comparable to those of series withdouble tunnel arthroscopically assisted techniques with bone plugs[2,3] and without them[4,5]. This study found that a single tibial tunnel arthroscopic technique without bone plugs for meniscal allograft transplantation significantly reduced pain and improved knee function in 94% of patients at minimum 3-year FU.

REFERENCES:

1. Verdonk PC, et al *Knee Surg Sports Traumatol Arthrosc.* 2006;14(8):694-706.
2. Ha JK, et al *Am J Sports Med.* 2010;38(12):2448-2455.
3. Rath E, et al *Am J Sports Med.* 2001;29(4):410-414.
4. Alentorn-Geli E, et al *Knee Surg Sports Traumatol Arthrosc.* 2010 Apr 14; [Epub ahead of print] PMID: 20390252
5. Gonzalez-Lucena G, et al *Arthroscopy.* 2010;26(12):1633-1640.

Lyophilised medial meniscus transplantations in ACL-deficient knees: A 19-year follow-up

M Binnet[1], B Akan[2], A Kaya[2]

[1]*Medicine School of Ankara University, Ankara, Turkey,* [2]*Medicine Schoolof Ufuk University, Ankara, Turkey*

Purpose
The treatment of meniscal tears has changed since the early 1980s. Meniscus transplantation emerged as a treatment option during that period. This study aims to present the long-term results of the first lyophilized meniscus allograft transplants in Turkey.

Methods
Between 1990 and 1992, four transplants of the medial meniscus combined with anterior cruciate ligament (ACL) reconstruction were performed on patients with a history of medial meniscectomy and anterior knee instability at our institution. For all patients who underwent meniscus lyophilised allograft transplantation and revision ACL reconstruction, clinical outcomes were evaluated over a mean period of 19 years of postoperative follow-up by clinical assessment, Tegner score, Lysholm score, Knee Society Score, radiography and magnetic resonance imaging (MRI).

Results
The median value of Tegner score was 3 before index surgery and 2.5 at year 19 postoperatively. The median value of Lysholm score was 60.5 before index surgery and 62.5 at year 19. All of the patients had Outerbridge grade IV osteoarthritis by X-ray examination at year 19.

Conclusion
Successful meniscus transplantation depends on many factors. This study examines the effect of allografts on these factors and describes experiences with lyophilised allografts in four male patients

A pilot study of the use of a polycarbonate-urethane implant (NUsurface®) for the treatment of postmeniscectomy medial knee pain

P Verdonk[1,2], A Dhollander[1], R Verdonk[1]

[1]Dept. of Orthopaedic Surgery and Traumatology, Ghent University Hospital, Ghent, Belgium, [2]Dept. of Orthopaedic Surgery, Stedelijk Ziekenhuis Roeselare, Roeselare, Belgium.

Purpose
To evaluate short-term clinical and MRI outcome of a polycarbonate-urethane meniscus replacement implant (NUsurface®, Active Implants Corp., Memphis, TN) for the treatment of postmeniscectomy medial knee pain.

Methods
Twelve patients aged 40 to 57 years with postmeniscectomy medial knee pain were treated with this new meniscus replacement device. Patients with evidence of grade IV articular cartilage loss were excluded. Clinical outcome was measured over 12 months by the KOOS, IKDC subjective, EQ-5D and VAS for pain. Serial MRI scans were taken at 6 weeks and 12 months of follow-up.

Results
The patients included in this study showed a significant clinical improvement after the procedure. The MRI findings of this pilot study were considered to be promising. No signs of deterioration of the surrounding cartilage or of the device were observed. One patient sustained a postoperative infection and 2 patients had a non-traumatic dislocation of the device at 3 and 6 months postoperative, probably due to size selection. All three patients were re-implanted with the device.

Conclusions
This investigation provided useful information on the safety and efficacy of this treatment in a challenging patient cohort. The short-term clinical and MRI outcome are promising. Large scale trials are mandatory to confirm the results and the reliability of this device.

The effect of arthroscopic partial medial meniscectomy on tibiofemoral position and stability

S Arno, MSc[1], S Hadley, MD[1], CP Bell, BS[1], KA Campbell, MD[1], M Hall, MD[1], OH Sherman, MD[1], PS Walker, PhD[1]

[1]*Department of Orthopaedic Surgery, NYU Hospital for Joint Diseases, New York, New York*

Introduction: The purpose of this study was to determine if partial medial meniscectomy of the posterior horn could significantly alter the anteroposterior (AP) position and laxity of the knee.

Methods: Five cadaveric knees were dissected to the capsule, preserving all ligaments and the quadriceps tendon. Each specimen was first tested on a rig where the AP position and laxity of the medial femoral condyle could be measured while a range of forces were applied from full extension to 90^{o} flexion. A 3 Tesla MRI was

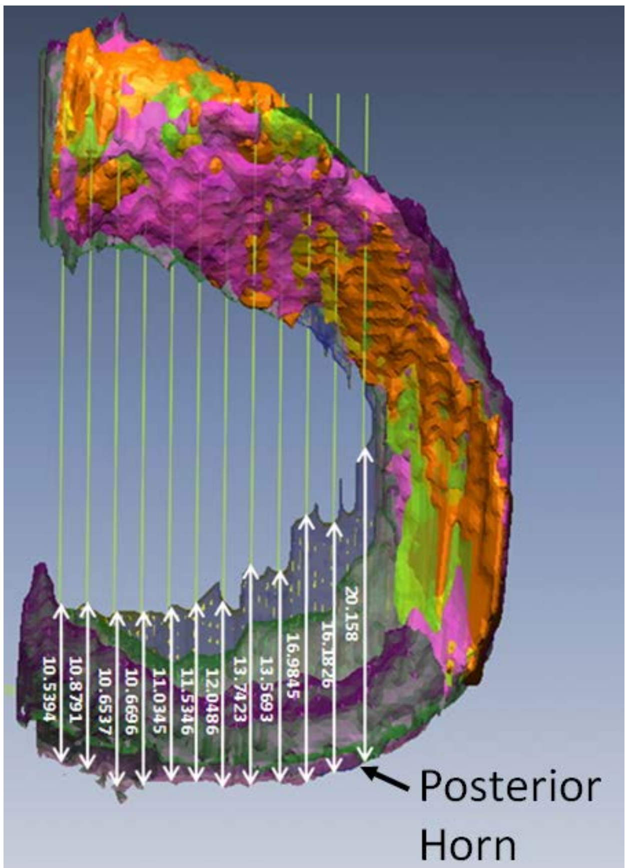
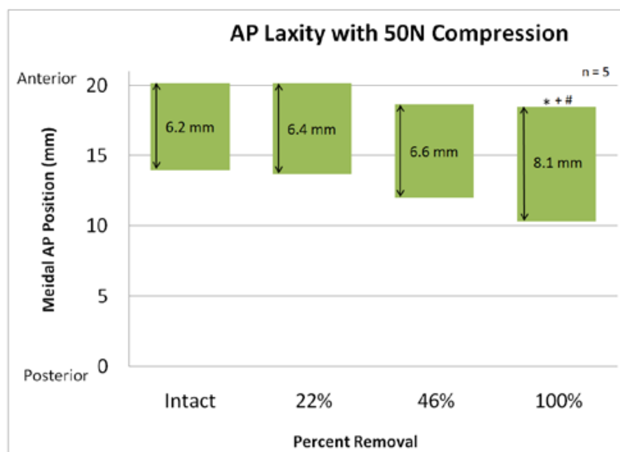


Figure 1: Rapidform was used to measure the width of the intact meniscus (Transparent), as well as after each resection (1st resection = Green, 2nd resection = Pink, 3rd Resection = Orange).

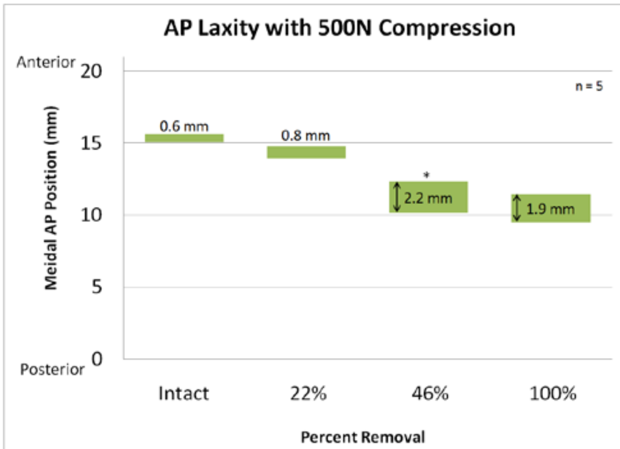
then performed for baseline measurements of the meniscus and medial femoral condyle position prior to partial meniscectomy. Arthroscopic partial medial meniscectomy aimed at 30% of the posterior horn was then performed, followed by repeat laxity testing and MRI scan. The sequence was then repeated for arthroscopic partial meniscectomy aimed at 60% and 100% of the posterior horn of the medial meniscus. The surfaces of the femur and tibia were digitized creating a point cloud representation of each surface which were rendered into 3D mesh solid body models. The solid body models were then transformed onto the fiducial points from each testing scenario to represent the anatomical positions of the femur and tibia. The AP position of the medial condyle was measured in each transformed state by determining the distance from the medial end-point of the circular axis to the posterior edge of the tibia, as defined by a posterior tibial plane. Laxity was then calculated as the difference in position between anterior and posterior shear (AP Laxity) as well as between internal and external torque (Rotational Laxity).



*Statistically significant when compared to the Intact knee
+Statistically significant when compared to the knee after 22% resection
#Statistically significant when compared to the knee after 46% resection

Graph 1: At 50N of compression, increasing the amount of medial meniscus resection leads to increased posterior translation of the medial femoral condyle.

Results: MRI analysis demonstrated that 22% ± 9% of the original width of the posterior horn was removed at the first resection, 46% ± 11% was removed at the second resection and the third resection was a full removal of the posterior horn. (Figure 1) The 22% resection had similar AP positions as the intact knee, whereas the 46% resection and the full removal of the posterior horn had a statistically significant more posterior position than intact. The 46% resection had AP positions that were statistically



*Statistically significant compared to the Intact knee

Graph 2: At 500N of compression, increasing the amount of medial meniscus resection leads to increased posterior translation of the medial femoral condyle.

similar to the full resection of the posterior horn. There was a trend for increased AP laxity at higher loads in the 46% and full meniscectomy but they were not statistically significant. (Graphs 1&2)

Conclusions: Partial medial meniscectomy equal to or greater than 46% resection of the original width of the posterior horn can significantly alter the AP position of the medial femoral condyle, although, there was no effect on AP laxity. Sub-total medial meniscectomy may not cause clinically relevant knee instability but it will lead to a more posterior position of the femur on the tibia.

Poly-urethane scaffold for the treatment of medial and lateral partial meniscus defects: A single center experience with focus on scaffold integrity.

P Verdonk[1,2], L Willemot, P Beekman, R Verdonk[1]

[1]Dept. of Orthopaedic Surgery and Traumatology, Ghent University Hospital, Ghent, Belgium, [2]Dept. of Orthopaedic Surgery, Stedelijk Ziekenhuis Roeselare, Roeselare, Belgium.

Objectives
A novel, biodegradable, polyurethane scaffold was designed to fulfill an unmet clinical need in the treatment of patients with painful irreparable partial meniscal defects. The purpose of this single center prospective study was to document the clinical outcome and scaffold integrity in patients with a minimum follow-up of 2 years.

Methods
Forty-one patients were treated with a poly-urethane scaffold for a painful partial meniscus defect. Of these 4 patients were lost to follow-up, 25 patients were treated on the medial side and 12 on the lateral side with a minimum follow-up of 2 years (range 2-4 years) Clinical outcomes were measured comparing VAS, IKDC, KOOS and Lysholm scores. Scaffold integrity was assessed during relook arthroscopy.

Results
Clinically and statistically significant improvements ($p<0.0001$) as compared with baseline were reported from 6 to 48 months in all clinical outcomes scores (VAS, IKDC, KOOS including Sport and Recreation subscale and Lysholm), demonstrating improvements in both pain and function. 5 out of 25 (20%) medial scaffolds and 3 out of 12 (25%) lateral scaffolds were torn, resulting in an extended debridement of the scaffold in 8 out of 37 cases (21%). All debridements had to be performed within the two year.

Conclusions
Poly-urethane scaffolds are a promising option to treat painful, partial meniscus defects. In 21% of cases, structural damage to the scaffold is observed most frequently within 2 years after implantation. Significant improvements were observed for all clinical outcome scores.

MRI of Meniscal Transplants

John V. Crues, III MD[1]

[1]*Radnet, Inc.*

Magnetic resonance imaging is commonly used as a diagnostic technique to evaluate knee menisci and meniscal transplants. MRI allows accurate evaluation of six characteristics of meniscal transplants useful in defining prognosis and evaluating surgical technique. They are graft placement, size, signal intensity, fragmentation, articular cartilage integrity, and injury to the subchondral bone. MRI techniques using a 1.0 Tesla extremity scanner will be discussed, and normal and abnormal examples of each of the six characteristics will be presented.