ACLR Femoral Flexible Reaming Technique Scientific Update

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Flexible reamers facilitate the creation of reproducible femoral sockets from the medial portal without needing to hyperflex the knee. The benefits of the flexible reaming technique include longer tunnel length, more anatomically placed tunnels, and reduced risk of posterior femoral cortex blowout and violation of important lateral structures. The following document summarizes published biomechanical and clinical studies that provide support for successful outcomes using the flexible reamer technique for anterior cruciate ligament reconstruction.

In Vivo Studies: Clinical Outcomes

Kim JG, Chang MH, Lim HC, et al

An in vivo 3D computed tomographic analysis of femoral tunnel geometry and aperture morphology between rigid and flexible systems in double-bundle anterior cruciate ligament reconstruction using the transportal technique. *Arthroscopy.* 2015;31(7):1318-1329. doi:10.1016/j.arthro.2015.01.021.

- Study compared femoral tunnel length, femoral graft-bending angle, posterior wall breakage, and femoral aperture morphologic characteristics between rigid and flexible systems
- Evaluated 54 patients (27 with flexible reamers and 27 with rigid reamers) using 3D computed tomography
- The AM femoral tunnel length and the graft-bending angle of the flexible reamer system were longer and less acute than those of the rigid reamers.

Bowers AL, Bedi A, Lipman JD, et al

Comparison of anterior cruciate ligament tunnel position and graft obliquity with transtibial and anteromedial portal femoral tunnel reaming techniques using high-resolution magnetic resonance imaging. *Arthroscopy.* 2011;27(11):1511-1522. doi:10.1016/j.arthro.2011.07.007.

- Study used 3D high-resolution MRI to compare femoral and tibial tunnel position and graft obliquity with single-bundle ACLR using transtibial (TT) or anteromedial (AM) reaming techniques
- Thirty patients were prospectively enrolled after primary bone-patellar tendon-bone ACLR by 2 groups of high-volume, fellowship-trained, sports medicine surgeons. A flexible reaming system was used for the AM portal technique.
- AM portal flexible reaming more accurately restored native ACL anatomy than TT. Although both techniques can capture the native femoral footprint with similar accuracy, the TT technique requires significantly greater posterior placement of the tibial tunnel, which results in decreased sagittal graft obliquity.

In Vitro Studies: Biomechanical Validation

Steiner ME, Smart LR

Flexible instruments outperform rigid instruments to place anatomic anterior cruciate ligament femoral tunnels without hyperflexion. *Arthroscopy.* 2012;28(6):835-843. doi:10.1016/j.arthro.2011.11.029.

- Study to compare the placement of anatomic femoral tunnels between flexible and rigid reamers
- Used 12 matched pairs of cadaveric specimens. Six pairs were drilled transtibial (TT) and 6 were drilled by the AM portal.
- TT drilling with a rigid instrument did not produce anatomic femoral tunnels. TT drilling with flexible reamers produced anatomic tunnels but they were close to the posterior femoral cortex. AM portal drilling with flexible reamers produced longer tunnels that were better positioned than rigid reamers drilled in the AM portal.

Forsythe B, Collins MJ, Arns TA, et al

Optimization of anteromedial portal femoral tunnel drilling with flexible and straight reamers in anterior cruciate ligament reconstruction: a cadaveric 3-dimensional computed tomography analysis. *Arthroscopy.* 2017;33(5):1036-1043. doi:10.1016/j.arthro.2016.11.004.

- Used 3-dimensional CAD technology to evaluate how knee flexion angles affect femoral tunnel length and distance to the posterior wall when using curved and straight guides
- Six cadaveric knees were placed in an external fixator at various degrees of flexion. Computed tomography scans were obtained for all flexion points. Using CAD software, virtual tunnels were created at each flexion angle. The distance from posterior cortex and tunnel dimensions were recorded.
- Flexible reamers resulted in a greater distance from the tunnel to the femoral cortex while preserving adequate tunnel length at lower flexion angles

Larson AI, Bullock DP, Pevny T

Comparison of 4 femoral tunnel drilling techniques in anterior cruciate ligament reconstruction. *Arthroscopy.* 2012;28(7):972-979. doi:10.1016/j.arthro.2011.12.015.

- Study to determine which femoral tunnel drilling technique most closely reproduced the anatomic femoral footprint with acceptable tunnel length and orientation
- Divided 20 cadaveric knees into 4 groups: transtibial (group 1), AM portal with rigid drill (group 2), AM portal with flexible drill (group 3), and outside/in technique (group 4)
- Transtibial drilling produces the most vertical and longest tunnels. Independent drilling techniques, including flexible or rigid reamers and outside/in techniques, produce the most anatomic tunnels but at the expense of tunnel length.

Dave LYH, Nyland J, Caborn DNM

Knee flexion angle is more important than guidewire type in preventing posterior femoral cortex blowout: a cadaveric study. *Arthroscopy.* 2012;28(10):1381-1387. doi:10.1016/j.arthro.2012.03.008.

- Straight and flexible guidewires were drilled at 90° and 120° flexion in 8 cadaveric knees. Guidewire intraosseous length and distance from the PFC were measured at both knee flexion angles.
- When knee flexion is limited, curved guides and flexible guidewires can help reduce PFC blowout risk and achieve longer tunnels

Silver AG, Kaar SG, Grisell MK, Reagan JM, Farrow LD

Comparison between rigid and flexible systems for drilling the femoral tunnel through an anteromedial portal in anterior cruciate ligament reconstruction. *Arthroscopy.* 2010;26(6):790-795. doi:10.1016/j.arthro.2009.10.012.

- Study to compare the differences in femoral tunnel length and distance to the lateral anatomic structures when using rigid or flexible reamers
- Straight and flexible guide pins were sequentially drilled through the center of the ACL femoral footprint footprint in 10 cadaveric knees. Tunnel length and distances to the peroneal nerve and femoral origin of the LCL were measured.
- Flexible reamers allow for longer femoral interosseous tunnels compared to straight guide pins. This is advantageous when suspensory fixation is used. There is minimal risk to the peroneal nerve and the femoral origin of the LCL unless lateral femoral wall blowout occurs.

Kalra K, Tang E, Atanda A, et al

Can flexible instruments create adequate femoral tunnel lengths at 90° of knee flexion in anterior cruciate ligament reconstruction? *Bull Hosp Jt Dis.* 2016;74(2):135-140.

- Studied flexible reamer drilled femoral tunnel lengths and distance to important lateral structures
- Flexible pins were inserted at 70°, 90°, and 120° of flexion. Intraosseous length was then measured.
- The specimens were dissected and the distance to critical structures was measured. Greater distances to the peroneal nerve were seen with increased flexion.
- Confirms adequate femoral tunnel lengths can be safely created without hyperflexion using flexible reamers

Russell RD, Dumont GD, Robertson WJ

Flexible reamers provide similar length and safer ACL tunnels without the need for knee hyperflexion: a cadaveric assessment of flexible and rigid reamers. *Tex Orthop J.* 2015;1:79-84. doi:10.18600/toj.0101.10.

- Study compared femoral tunnel placement and orientation with flexible and rigid reamers
- Nine matched-pair cadaver femora were divided into 2 groups (9 flexible reamers and 9 rigid reamers). Specimens drilled with rigid reamers were placed at 115° of flexion and specimens drilled with flexible reamers were placed at 90° of flexion.
- Flexible reamers reproducibly created ACL tunnels with greater obliquity and were farther away from the posterior cortex of the femur compared to rigid reamers

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