

Summary of Clinical Research Involving Cayenne Medical Inc. Products

By Dev K. Mishra, M.D.
Medical Director, Cayenne Medical Inc.
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At Cayenne Medical, we are committed to proper scientific investigation of the potential clinical benefits of using our devices. We are pleased to have multiple studies in clinically relevant areas currently underway by independent researchers, at highly reputable institutions in the U.S. and Internationally. Out of respect for the integrity of the scientific process, we will not cite specific authors until the studies have been published in peer-reviewed journals, presented at professional meetings, or until the author gives us permission. In the following sections, I will outline for you our published or presented research specific to Cayenne products, present selected topics on relevant subjects relating to clinical procedures, and give a brief overview of planned studies and questions to be answered for the remainder of 2011. Additionally, I will outline the other available forms of clinical material, such as White Papers. This summary is meant to be a concise review of the available research but we strongly encourage interested readers to consult the original source documents whenever possible. Many published studies and White Papers are available for download from our website or are available upon request from your Cayenne Medical technical representative.

Biomechanical Testing of the Femoral AperFix[®] Device Shows Ultimate Load To Failure Equal To Cross-Pin Fixation for ACL Reconstruction

This study is available as a White Paper and shows that the time-zero strength of fixation of the femoral AperFix device is equal to two of the most commonly used femoral soft-tissue fixation devices, and stronger than interference screw fixation.

- o Abell, B., and Wenger, K. "Biomechanical comparison of femoral fixation devices in soft tissue ACL reconstructions." *Cayenne Medical Inc., White Paper*

Ultimate load to failure (N)	
AperFix [®]	1479 +/- 261
BioTransFix [®]	1472 +/- 244
Endobutton [®]	1311 +/- 178
Biointerference screw	935 +/- 147

Premarket scientific studies of basic principles highlight the benefits of aperture fixation, shorter graft length, and reproduction of the native helical ACL architecture to give the best possible ACL construct. The Cayenne AperFix[®] implants allow the surgeon to incorporate these best practices into the reconstruction.

- **Animal studies show that shorter graft intra-osseous lengths are equally effective in terms of biomechanical testing compared to longer intra-osseous lengths**
- **Healing takes place principally at the aperture of the implant where the tendon is firmly compressed against bone**
- **An implant that allows aperture fixation at the tunnel openings will give the shortest intra-articular graft length**
- **The shortest intra-articular graft length yields stiffness closest to the native ACL**
- **A double-bundle helical graft architecture closely replicates the native ACL in terms of mechanical testing**
 - o Brown CH Jr, Sklar JH. "Endoscopic anterior cruciate ligament reconstruction using quadrupled hamstring tendons and Endobutton femoral fixation." *Tech Orthop* 13: 281–298, 1998
 - o Hoher J, Livesay GA, Ma CB, et al. "Hamstring graft motion in the femoral bone tunnel when using titanium button/polyester tape fixation." *Knee Surg Sports Traumatol Arthrosc* 7: 215–219, 1999
 - o Hoher J, Scheffler SU, Withrow JD, et al. "Mechanical behavior of two hamstring graft constructs for reconstruction of the anterior cruciate ligament." *J Orthop Res* 18: 456–461, 2000
 - o Rowden NJ, Sher D, Rogers GJ, et al. "Anterior cruciate ligament graft fixation Initial comparison of patellar tendon and semitendinosus autografts in young fresh cadavers." *Am J Sports Med* 25: 472–478, 1997

- o Yagi, M., Wong, E.K., Kanamori, A., Debski, R.E., Fu, F.H., Woo, S. L-Y. "Biomechanical Analysis of an Anatomic Anterior Cruciate Ligament Reconstruction." *Am J Sports Med.* 2002; 30(5): 660-666.
- o Yamazaki, S., Yasuda, K., Tomita, F., Minami, A., Tohyama, H.: "The effect of intraosseous graft length on tendon-bone healing in anterior cruciate ligament reconstruction using flexor tendon" *Knee Surg Sports Traumatol Arthrosc* 2006; 14:1086-1093.
- o Zantop, T., Ferretti, M., Bell, K.M., Brucker, P.U., Gilbertson, L., and Fu, F.H. "Effect of Tunnel-Graft Length on the Biomechanics of Anterior Cruciate Ligament Reconstructed Knees: Intra-Articular Study in a Goat Model." *Am. J. Sports Med.* 2008; 36: 2158-2166.

Published biomechanical study shows that the single-tunnel double-bundle Cayenne AperFix® ACL reconstruction provides a closer approximation to intact knee kinematics than single bundle reconstructions

This cadaveric biomechanical study compared the kinematics of four conditions: ① The intact knee, ② The ACL deficient knee, ③ Single bundle reconstruction using quadrupled hamstring tendon, and ④ Single tunnel double bundle reconstruction

- **The single-tunnel-double-bundle anterior cruciate ligament reconstruction more closely restored the intact knee kinematics than the single-bundle anterior cruciate ligament reconstruction at low flexion angles (< or =30 degrees) under the anterior tibial load and simulated muscle load (P < .05). This double-bundle anterior cruciate ligament reconstruction using a single tunnel can better restore anterior tibial translations to the intact level compared with single-bundle anterior cruciate ligament reconstruction at low flexion angles, but it did result in some overconstraint of the knee joint at high flexion angles. The clinical significance of overconstraint at higher flexion angles is unknown, as separate clinical studies have shown excellent functional outcomes and patient satisfaction.**
- **The AperFix® femoral and tibial implants allow the surgeon to rotate the graft bundles, resulting in a helical double bundle construct that closely approximates the native ACL architecture**

- o Gadikota, H.R., Seon, J.K., Kozanek, M., Oh, L.S., Gill, T.J., Montgomery, K.D., Li, G. "Biomechanical Comparison of Single-Tunnel Double-Bundle and Single-Bundle Anterior Cruciate Ligament Reconstructions." *Am J Sports Med*, 2009 May; 37(5): 962-9.

Published clinical studies and white papers show outstanding near-term functional results, no tunnel widening, and highlight technical aspects of ACL reconstruction and revision

- **Significant improvements in Lysholm score compared to cross-pin fixation**
 - **No tunnel widening**
 - **Significant improvements in stability, IKDC score, single leg hop, surgical time**
 - **Potential for differential bundle tensioning of the anteromedial and posterolateral bundles**
 - **Technical note highlights straightforward steps in implant removal for revision**
- o Burke, Robert. "Tunnel widening comparison for AperFix vs Cross Pin." *Cayenne Medical, Inc. White Paper*
 - o Connor, Geoff. "Outcomes in ACL Reconstruction Using the AperFix System." *Cayenne Medical, Inc. White Paper*
 - o Cooper, W., Machen, M.S., Nelson, J., Owens, B.D. "Anterior Cruciate Ligament Revision of a Relatively New Implant System." *Orthopedics*, 2009 May; 32(5): 326-328.
 - o Schachter, A.K., and Montgomery, K.D. "Single-Tunnel Double-Bundle Anterior Cruciate Ligament Reconstruction." *Tech Knee Surg*, 2009; 8(2) 110-114.
 - o Uzumcugil, O., Dogan, A., Dalyaman, E., Yalcinkaya, M., Akman, E., Ozturkmen, Y., Caniklioglu, M. "AperFix versus TransFix in Reconstruction of Anterior Cruciate Ligament." *J Knee Surg* 2010; 23(3):29-35.

Several prospective high level of evidence studies are underway moving towards further validation of Cayenne AperFix® femoral and tibial fixation as an ACL reconstructive method leading to superior clinical and functional results. These studies will likely take a year or more to complete. Note also that some studies are proposed but not finalized.

Prospective comparison of tunnel widening compared to cortical button fixation

- Study underway at the Hughston Clinic, Columbus, GA
- Radiographic assessment of tunnel widening up to 6 months postoperatively

Biomechanical comparison of multiple ACL reconstruction tibial fixation systems

- Study being conducted at The Ohio State University

Prospective randomized clinical comparative studies

- Proposed study with the Kerlan-Jobe Orthopaedic Clinic comparing AperFix® to cortical button and/or cross pin fixation

Prospective clinical and functional outcomes studies

- Comparison of hamstring autograft AperFix® fixation to patellar tendon autograft at Brigham Young University
- Prospective outcomes study from Lake Success, NY, and San Diego, CA
- Prospective outcomes and radiographic study from Miami, FL

Published technical notes and case series highlight the ease of use and reproducibility of the Cayenne AperFix® femoral and tibial implants for single tunnel double bundle PCL reconstruction

- **Portal placement, tunnel placement, and surgical steps described in detail**
- **A method of differential tensioning of the anterolateral and posteromedial bundles is described utilizing a single tunnel double bundle technique**
 - Baker, C.L. Jr., and Baker, C.L. III. "Arthroscopic PCL reconstruction with a soft tissue system." *Orthopedics Today SuperSite* publication: <http://www.orthosupersite.com/view.aspx?rid=66151>
 - Uribe, J.W., Vargas, L., Leo, B.M. "Arthroscopic PCL reconstruction with a novel all-inside femoral fixation device: a single-incision technique." *Orthopedics* 2011. 33(2): 92-97.

Ongoing biomechanical research will investigate the influence of differential tensioning of the graft bundles during single tunnel double bundle PCL reconstruction

- **Investigation conducted at the Cleveland Clinic and UHZ Clinic, Miami, FL**
- **Cadaveric study using six degrees of freedom analysis**
- **Four conditions tested: intact PCL, transected PCL, both bundles tensioned at 30° flexion, and differential tensioning of AL bundle at 90° and PL bundle at 0° flexion**