Arthroscopic rotator cuff repair has become a prevailing method of surgical treatment of full thickness rotator cuff tears in recent years. Despite all technical advances, cuff re-tear persists as one of the major potential complications of this surgery. Early suture anchor pullout is an important mode of fixation failure. In a recent retrospective study, Benson1 reported suture anchor pullout in 11% of patients with cuff tears larger than 3 cm. Footprint restoration, combined with double row cuff fixation to the bone using different suture anchor configurations, has been advocated as a solution for this problem. While double row fixation can add some strength to rotator cuff fixation, it doesn’t solve the problem of anchor implants. A study performed by Barber2 has shown that anchors designed to function as lateral-row fixation provide fixation strength inferior to that of medial-row anchors and are more likely to be subjected to suture slippage. Supporting this finding are clinical case reports such as the one published by Tsiouria3, who reported on isolated lateral row anchor pullout after double row rotator cuff repair.

Several risk factors for rotator cuff fixation failure have been identified, among them size of cuff tear, age of patient and presence of infraspinatus fatty degeneration, the last one being described as the most important predictive factor for re-tear in a recent study performed by Oh4. Combining these findings with observations of increasing suture anchor pullout risk in larger cuff tears extending to the infraspinatus region as reported by Benson1, we can conclude that larger posterosuperior cuff tears pose the greatest risk for a re-tear and also the greatest risk for suture anchor pullout. Adding more suture anchors, especially as a lateral row to augment a repair does not seem to be the right solution for this problem.

Classic open transosseous suture rotator cuff repair has been regarded for years as a gold standard for surgical treatment of rotator cuff tears5 and many studies have thoroughly documented the results of this technique. Its major advantages are absence of any implants in the footprint region and restoration of the footprint area. The only major disadvantage of the open transosseous suture rotator cuff repair is its invasive open approach.

A new device facilitates an arthroscopic transosseous rotator cuff repair without the use of any suture anchors (ArthroTunneler®, Tornier, Inc. Edina, MN). The technique closely replicates the open transosseous cuff repair. Since the transosseous suture repair can now be performed through arthroscopy, we have a solution that combines the advantages of both anchorless transosseous suture repair and the arthroscopic minimally invasive approach.
Case Presentation:

A 61 year old, right hand dominant male patient came to our clinic because of persistent pain in his right shoulder. The patient described the onset of pain as insidious, becoming exaggerated with physical activity, but very disturbing as well during the night. Conservative treatment with rest, NSAID and physical therapy has been tried by his General Practitioner. Upon examination he had only a slight limitation of active range of motion with elevation of 120°, external rotation of 70° and at internal rotation he reached to L1. There was a painful arc sign present and the Jobe test was positive. The Constant score was 51 and the pain was graded as 7 on visual analog scale by the patient. A shoulder MRI was ordered and showed an isolated supraspinatus tendon tear with retraction of about 1 cm in the coronal plane with stage I Guttalier supraspinatus muscle fatty infiltration. Based on all information gathered, the patient was counseled to undergo an arthroscopic rotator cuff repair. At arthroscopy a complete tear of supraspinatus extending into the anterior part of infraspinatus tendon was identified. The tear was typically degenerative in nature with poor tendon quality and delamination. The arthroscopic rotator cuff repair was performed with four high strength size 2 sutures passed through two transosseous tunnels using the ArthroTunneler device. Medial tunnels were drilled at the articular margin just at the edge of the cartilage to obtain a large footprint fixation to promote healing of the degenerative tendon. Two sutures were tied together to create a medial inverted mattress suture, the remaining two sutures were passed and tied separately as a simple suture, one in the anterior and one in the posterior part of the supraspinatus tendon. Postoperative treatment consisted of early shoulder passive motion and active exercises to strengthen the scapular stabilizers. After the sixth week following surgery, progressively active exercises for rotator cuff were introduced. The pain subsided in the first days after surgery. Accordingly, all pain medication was discontinued after one week. At 12 weeks after surgery, the Constant score was 82 from a baseline measured pre-operatively of 51 and at that time resistance exercises with weights were added to the rehabilitation program. The patient went on to complete recovery of his shoulder function.
Biomechanical Study:

Poor bone quality in the greater tuberosity region in patients with chronic rotator cuff tear is of concern for the reliability of any fixation. Speaking in favor of the transosseous technique are the well-documented excellent long-term results of the classic open transosseous rotator cuff repair. There is also published biomechanical evidence suggesting that transosseous sutures can provide at least as reliable fixation as certain standard suture anchor configurations. A recent study performed by Pietschmann could not demonstrate any significant difference, in displacement or pullout strength in either healthy and osteopenic bone among the tested suture anchor configurations and the traditional transosseous suture repair construct group. As far as we know, no studies have been published in the peer-reviewed literature that would compare the fixation strength of transosseous suture repair performed by the ArthroTunneler to any standard arthroscopic anchor based repair constructs.

For this reason we recently performed a biomechanical study to compare the pullout strength of a transosseous suture repair construct performed using the ArthroTunneler device. Fresh frozen cadaveric humeri were used for the testing. After releasing the rotator cuff tendon sharply from its insertion on the greater tuberosity, the repair with one of the several compared surgical techniques was performed. The construct was then subjected to cyclic loading using custom built device. The design of this device enabled us to control the amount of load applied to the tendon. During the testing the load was progressively increased from 50 N to 100 N, 150 N and finally to 200N. Two moments have been defined as points of failure, first when more than 2 mm of gap formation have been observed (loss of fixation) and second when the tendon was pulled off the bone completely (complete failure of fixation). The average number of cycles to loss of fixation was 651 cycles (SD±118) for the double row mattress suture repair, 625 (SD±83) for the double row suture bridge anchor repair and 638 (SD±63) for the transosseous suture bridge repair construct. Complete fixation failure occurred on average after 716 loading cycles (SD±110) in double row mattress suture repair, 678 loading cycles (SD±67) in double row suture bridge anchor repair and 692 cycles (SD±64) in transosseous suture bridge constructs. Based on these findings we conclude that arthroscopic transosseous rotator cuff repair performed with the ArthroTunneler device provides similar initial mechanical strength of fixation to the typical double row anchor based repair constructs without potential for any implant related complications.
Summary:

The ArthroTunneler is a novel device that enables arthroscopic replication of the classic transosseous open rotator cuff repair. The potential advantages of this new technique include not only the well known benefits of the minimally invasive arthroscopic surgical approach, but also avoidance of all potential implant related complications. Due to well designed instruments, the transosseous sutures can be placed in a more predictable fashion compared to classic transosseous suture passing with a curved needle. In our opinion this also contributes to improved strength of cuff fixation and makes the technique more reproducible and also relatively easy to master.

Our cadaveric biomechanical study demonstrated that the transosseous cuff repair construct performed with the ArthroTunneler device provides an initial mechanical fixation strength comparable to typical double row anchor based repair constructs. In our study, a relatively basic suture configuration was used to repair the tendon. As the main failure modes observed were suture cutting through the tendon and knot slippage, it would be reasonable to expect that by using a more complex suture configuration and by passing three sutures through each tunnel, further improvement in fixation strength could be obtained.

As practical experience with the ArthroTunneler device allows one to employ more complex suture construct repair techniques we feel there is potential to further improve on the outcomes of arthroscopic rotator cuff repair by using this device.