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ISKSAA — Knee & Shoulder Arthroscopy And Arthroplasty

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ISKSAA International Society for Knowledge for Surgeons on Arthroscopy and Arthroplasty

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Aims and Scope

Journal of Arthroscopy and Joint Surgery (JAJS) is committed to bring forth scientific manuscripts in the form of original research articles, current concept reviews, meta-analyses, case reports and letters to the editor. The focus of the Journal is to present wide-ranging, multi-disciplinary perspectives on the problems of the joints that are amenable with Arthroscopy and Arthroplasty. Though Arthroscopy and Arthroplasty entail surgical procedures, the Journal shall not restrict itself to these purely surgical procedures and will also encompass pharmacological, rehabilitative and physical measures that can prevent or postpone the execution of a surgical procedure. The Journal will also publish scientific research related to tissues other than joints that would ultimately have an effect on the joint function.

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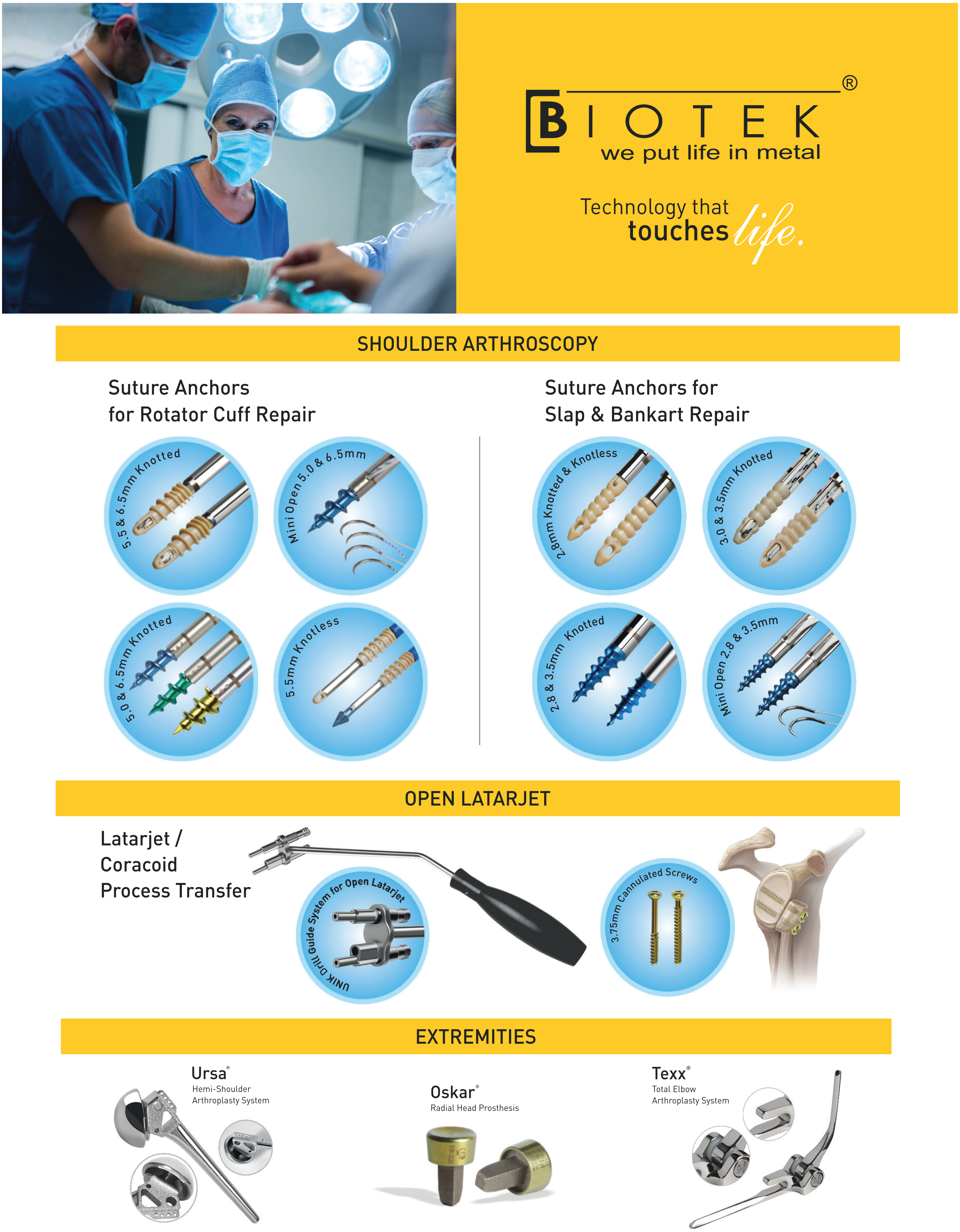

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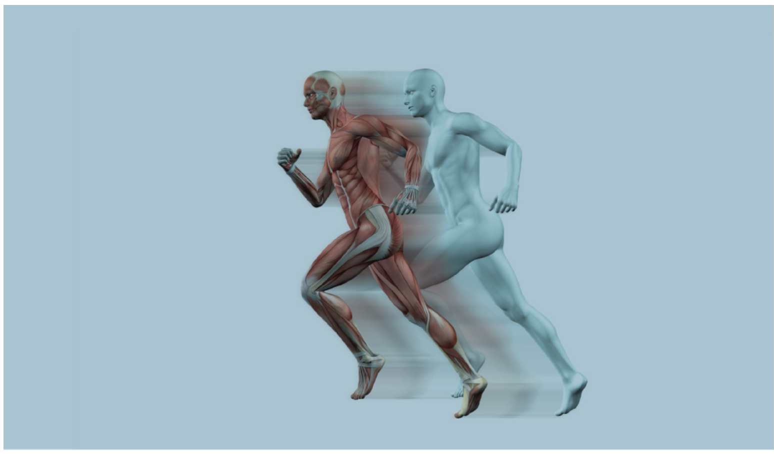

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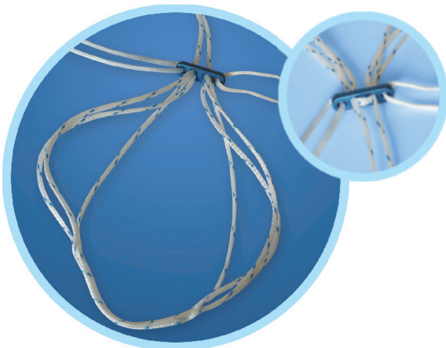

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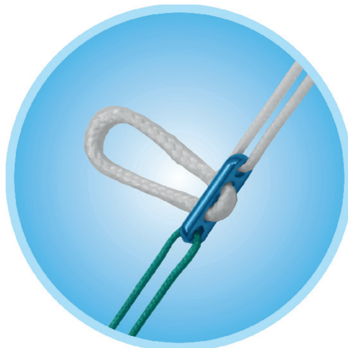

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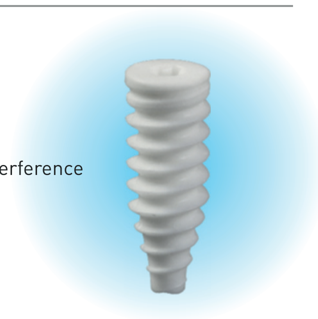

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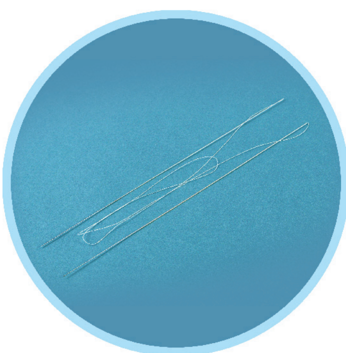

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Comparing clinical and patient reported outcomes of suture anchor and transosseous repairs of quadriceps tendon rupture

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ABSTRACT

Quadriceps tendon ruptures are relatively uncommon but severe injuries to the extensor mechanism are usually treated surgically. The purpose of this investigation was to compare the results following a standard transosseous (TO) repair to a suture anchor (SA) repair. A retrospective cohort was analyzed from a single institution with a total of 10 SA and 17 TO repairs meeting inclusion criteria. Average clinical follow up was 5.8 months and 15.2 months for the SA and TO groups, respectively. Re rupture rates were 9% and 13%, with total complication rates of 27% and 32% for the SA and TO groups, respectively. Knee flexion was 117° for SA repairs and 128° for TO repairs after a minimum of 3 months. Mean Lysholm scores were 63 and 72.8, recorded at a mean of 4.7 years and 5.5 years after the SA and TO repairs, respectively. Operative time was similar between both groups at 93 min and 90 min for the SA and TO groups, respectively. This study showed that the clinical results, re rupture rates, complications, and operative times were similar between suture anchor and transosseous repairs of the quadriceps tendon. Therefore both techniques are appropriate for the management of this debilitating injury.

1. Introduction

A rupture of the quadriceps tendon is a relatively uncommon injury representing 1.3% of musculoskeletal soft tissue injuries, and typically occurs in patients that are older than forty years of age.[1] A tension failure of the extensor mechanism often occurs via a forceful contraction of the quadriceps muscles on an eccentrically loaded knee, as may occur while catching a fall. Frequently these patients have conditions that predispose them to having an unhealthy tendon, such as diabetes, renal failure, hyperparathyroidism, rheumatoid diseases, metabolic abnormalities, and/or collagen diseases. Other reasons for an unhealthy tendon include obesity, and use of certain medications such as anabolic steroids, corticosteroids, statins, or quinolones.[2] Ruptured tendons have been shown to harbor histopathological degenerative changes such as hypoxic degenerative tendinopathy, mucoid degeneration, tendolipomatosis, and calcifying tendinopathy.[3] A rupture of the quadriceps tendon usually disrupts the extensor mechanism, causing a persistent extensor lag and precludes efficient ambulation. Physical examination findings often include a palpable suprapatellar gap, acute anterior knee pain, and the inability to extend the knee. Due to the often-poor results of non-operative treatment, surgical intervention is usually the treatment of choice.[2,4]

The end-to-end repair of quadriceps tendon injuries has been reported as far back as 1887, when McBurney repaired the tendon with catgut and silver wire with perfect recovery of function. In the first large-scale report of the injury, Siwek and Rao reported on 33 patients with 36 quadriceps ruptures. Based on their experiences, they advocated immediate end-to-end repair with immobilization in a cylinder cast for 6–10 weeks. Some of their repairs were augmented by Bunnell pull-out wires, rectus femoris tendon flaps, or circumferential wires through the intact quadriceps tendon secured to a *trans*-patellar bolt.[5] Contemporary authors have advocated end-to-end repair for mid-substance tears or a technique of transosseous suture repair for avulsions of the tendon from the patella ([6,7]). Given the rarity of quadriceps tendon ruptures, the

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evolution of treatment options has lagged behind other more common soft tissue injuries, such as those occurring in the shoulder and ankle.[8,9]

Suture anchors have recently been employed in quadriceps tendon repair.[10–14] Suture anchors have been noted to have equivalent strength to the transosseous tunnels in biomechanical testing, but no clinical comparisons between standard and suture anchor repairs are available. In order to obtain a better understanding of the viability of this new technique, we performed a retrospective series to compare all suture anchor (SA) repairs and transosseous (TO) repairs performed at our institution over a ten-year period. In particular, there was a focus on the complication rates, clinical outcomes, and patient reported outcomes of each technique.

2. Materials and methods

Patients were selected by searching our surgical database for those who had undergone quadriceps tendon repair at our institution between 2004 and 2014. Patients were excluded if their repair wasn't acute (more than 2 weeks after injury), if they failed to follow-up, if a technique other than transosseous sutures or suture anchors was used, and if the injury was not isolated to the quadriceps tendon. Approval from our institution's institutional review board was obtained. A total of 55 patients were identified with 27 meeting our inclusion criteria. Four patients were excluded due to graft augmentation, 2 had direct repairs, 1 had a chronic TO repair, and 1 had a SA repair in the setting of a total knee arthroplasty. Of the remaining eligible patients 20 were lost to follow-up prior to their 2-month clinical check.

Operative reports, radiographs, and follow up notes were available for review. Patient demographics including age, gender, body mass index (BMI), and comorbidities were recorded. Details about the operation including the surgical time, type of repair, number and type of sutures and/or suture anchors, and suture configuration were also noted. Postoperatively, attention was paid to their strength, range of motion, and if the presence of an extensor lag existed. The charts were specifically reviewed for complications including the occurrence of re-rupture, superficial or deep infection, reoperation for any cause, and venous thromboembolism.

To determine patient reported outcomes a standardized telephone questionnaire was administered. Patients were asked: 1) Have you undergone any further surgeries or procedures for your knee? 2) Are you satisfied with the results of your quadriceps tendon repair? The Lysholm score, a validated patient reported outcome score focusing on activities of daily living, was also recorded for each patient.[15] In the case of patients with bilateral injuries no effort was made to obtain separate scores for each knee.

2.1. Surgical technique

The patient is placed supine on the operating table and induced with general anesthesia. A pneumatic tourniquet is placed on the proximal thigh and the extremity is prepared and draped in sterile fashion. The limb is exsanguinated and the tourniquet is inflated. A midline incision is made from about 6 cm proximal to the patella extending to just past the proximal pole for SA repair or just distal to the distal pole for TO technique. At this point the dissection is carried down to find the quadriceps tendon rupture. The retinaculum is inspected on both the medial and lateral sides to visualize the extent of tearing. All hematoma is debrided, along with the frayed edges of tendon and any fibrous tissue is removed from the proximal pole of the patella. The superior pole of the patella is decorticated to create a small trough to expose a bleeding cancellous bone surface.

For the transosseous tunnel repair 2 heavy non-absorbable sutures are woven into the quadriceps tendon utilizing a locking Krackow whipstitch.[16] Depending on surgeon preference, #2 or #5 Fiberwire (Arthrex, Inc., Naples, Florida) or Ethibond (Ethicon Inc., Johnson & Johnson, Somerville, NJ) were utilized. Three parallel drill holes are made through the patella from proximal to distal (1 central, 1 medial, and 1 lateral). The 4 strands of suture are subsequently shuttled through the drill holes (2 centrally) and tied over the distal patella with the knee in full extension.

For the suture anchor repair (see Fig. 1) a pilot drill hole may be made to the intended depth of anchor placement with a 2.5 mm drill, depending on surgeon preference. In general 2 suture anchors are placed in the superior pole of the patella. The most commonly used anchors at our institution have been 5 mm and 6.5 mm titanium corkscrew anchors (Arthrex Inc., Naples, Florida), though biocomposite and all suture anchors have also been utilized. These are loaded with #2 Fiberwire which is then woven into the quadriceps tendon using a modified Mason-Allen configuration as described in previous reports.[12–14,17]

Following the tendon repair, the retinaculum is repaired and the skin is closed according to surgeon preference. The patient's leg is placed in a knee immobilizer or hinged knee brace locked in extension and the patient is made weight bearing as tolerated with crutches. The physiotherapy regime includes physical therapy focusing on passive range of motion for the first six weeks, followed by active range of motion until 12 weeks and finally gradual resistance training until 6 months.

2.2. Statistics

For categorical data the Fischer's exact test was utilized. For continuous data the student's t-test was utilized. Significance values were set at 0.05. Patients with re-rupture or hardware failure were excluded from ROM and strength analysis. A power test was not performed at the beginning of the study due to the low incidence of this type of injury (<1.37/100,000 patients per year).[25]

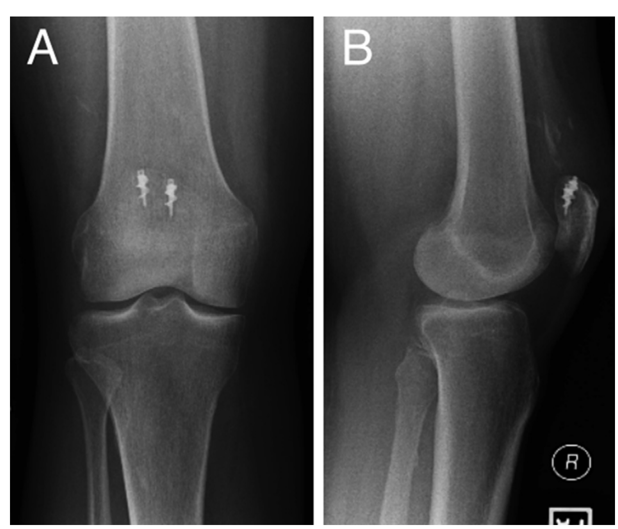

Fig. 1. (A) Anteroposterior and (B) lateral radiographs following SA quadriceps tendon repair with two titanium anchors.

3. Results

3.1. Demographics

Out of patient who met our inclusion criteria we identified 10 patients with 11 repairs in the suture anchor group and 17 patients with 22 repairs in the *trans*-osseous tunnel group. The mean age was 54 years (range 35–74) for the SA group and 49 years (range 33–68) for the TO group (Table 1, p = 0.18). There were 8 males and 2 females in the SA group with 15 males and 2 females in the TO group. Average BMI was 33.9 for SA and 34.5 for TO (p = 0.89). In aggregate 40.7% of patients had a BMI less than 35 and 59.3% had a BMI of 35 or greater. Clinical follow-up averaged 5.8 and 15.2 months for the SA and TO groups, respectively.

There were nine surgeons who performed the repairs, an average of 2.61 days (range 0–13 days) after the injury. The clinical diagnosis of a quadriceps tendon rupture, which was confirmed during surgery, was based on the mechanism of injury, inability to maintain a straightened knee, tenderness superior to the patella, and a palpable defect in the quadriceps tendon.

3.2. Clinical outcomes

The last clinical follow up averaged 5.8 months (range 2.6–11.5) and 15.2 months (range 2–69.5) for the SA and TO groups, respectively (p = 0.12). Fourteen patients were reached for a phone interview (6/10 for anchors and 8/17 for tunnels) with a mean follow up of 4.7 years and 5.5 years for the anchor and tunnel groups, respectively.

At final clinical follow-up the mean knee flexion angles were 109° (Table 2, range 80–135) in the SA group and 126° (range 85–135) in the TO group, a significant difference (P = 0.039). When patients with less than 3 months of clinical follow-up were excluded from the analysis mean flexion was 117° and 128° for patients with SA and TO repairs, and didn't reach significance (p = 0.23). Quadriceps strength was similar for both groups, averaging 4.83/5 for SA patients and 4.73/5 for TO patients (p = 0.63).

3.3. Operative time

Operative time was similar for both cohorts (p = 0.76). Surgical time averaged 93 min for the SA repair and 90 min for the TO repair.

Table 1
Demographics of subjects.

	Group		
	SA (n = 10)	**TO** (n = 17)	**Total** (n = 27)
Age (mean, range)	54, (35–74)	49, (33–68)	51.4
BMI (mean, range)	33.9, (21.8–57.8)	34.5, (21.7–77.3)	34.9
Sex (male)	80%	88%	85%
Injury Mechanism (%)			
Simple fall	60	56	57
Fall down stairs	10	17	14
Fall from height	0	11	7
Other	30	16	22
Co-morbidities (%)			
Hypertension	70	47	56
Diabetes	50	29	37
Kidney disease	10	0	4
Other	40	18	26
Injury Side (no.)			
Right	4	6	10
Left	5	6	11
Bilateral	1	5	6

Abbreviations: SA, suture anchor; TO, transosseous; BMI, body mass index; no., number.

Table 2
Results.

	Group	
	SA	TO
Knee flexion (mean all subjects)	109° *	126° *
Knee flexion (mean >3mo follow-up)	117°	128°
Quadriceps strength (mean)	4.8/5	4.7/5
Operative time (mean)	93 min	90 min
Re-rupture (%)	9	14
Complications (%)	27	32
Lysholm Score (mean, range)	63, (33–100)	72.8, (24–100)
Satisfied (% Yes)	67	88

Abbreviations: SA, suture anchor; TO, transosseous; *, $p < 0.05$.

3.4. Complications

There were three total complications (27%) in SA repairs, including one re-rupture (9%). One patient had a superficial wound dehiscence in the immediate post-operative period that was treated with a negative pressure dressing. Another patient had one anchor (out of 3 total) pull out of the patella, as seen radiographically. He was still able to maintain a straight leg raise without an extensor lag. In the TO group there were seven total complications (32%), including 3 re-ruptures (14%). One of the re-ruptures was associated with a wound dehiscence that occurred due to vigorous knee flexion at physical therapy, requiring operative debridement. One patient developed a deep vein thrombosis (DVT). Two patients were found to have arthrofibrosis that required arthroscopic lysis of adhesions. One individual was placed on oral antibiotics for a superficial wound infection. There were no significant differences between the groups for re-rupture (p = 1.0) or total complications (p = 1.0).

3.5. Subjective and functional outcomes

Fourteen patients were reached for a phone interview (6/10 for SA and 8/17 for TO) with a mean follow up of 4.7 years and 5.5 years for the SA and TO groups, respectively. Lysholm scores were slightly higher in the TO cohort (72.8), compared with the SA group (63), though this was not found to be significant (p = 0.53). When looking at those patients with the lowest scores: one patient with a score of 24 had a clinical course significant for DVT. Another patient with a score of 36 required revision surgery for a re-rupture. 67% of SA repairs and 88% of TO repairs were satisfied with their results.

4. Discussion

This is the first study that we are aware of to compare suture anchor and transosseous repairs of acute quadriceps tendon ruptures. Previously 10 cases of quadriceps tendon repair with suture anchors have been described in the literature as case reports and small case series.[10–12,14,18] Mille et al. have further provided a level IV report of 13 cases.[13]

When comparing the study demographics of our cohort with previously published reports of quadriceps tendon rupture, the age (51.4 years) of our patients was similar to other studies (mean 57 years).[19] The low velocity mechanism of injury in 74% of our patients was also comparable to the reported 61.5% sustaining simple falls and 23.4% having a fall from stairs. Bilateral, simultaneous rupture was relatively common at 15% in our cohort. In a review of bilateral quadriceps tendon ruptures, Shah identified that those patients with multiple chronic diseases where more susceptible to such an injury.[20] Forty-three percent of their 66 cases had renal disease, and duration of renal dialysis was related to spontaneous rupture. Only one of our patients had renal disease and we didn't note any spontaneous ruptures. The majority of our patients were obese, with an average BMI of 34.9, which we believe was the most significant predisposing factor towards quadriceps tendon rupture in our cohort.

The aggregate rate of re-rupture in our study was 12%, which was slightly higher than other reports (range 0–8.3%),[19] but similar to the 15% reported by Mille et al. The only significant difference between the two repairs in our study was in knee flexion (favoring the TO technique), however when excluding patients with less than 3 months of clinical follow-up this difference failed to reach significance. The average knee flexion achieved in our study (117° for SA and 128° for TO) was also similar to previous reports. Lysholm scores and satisfaction rates were higher in the TO repair group in our study, however the difference was not significant.

There were a number of limitations to this study. A large number of patients were lost to follow-up (42.5%), which is likely due to the population of patients seen at a Level I urban trauma center and the difficulty in ensuring these individuals return for post-operative care. Previously reported dropout rates have been 0–42.8%.[19] Due to the retrospective nature of this study and the large number of surgeons there was also no standardized therapy protocol. While the length of clinical follow-up was relatively short in our study, we believe that it was sufficiently long to capture functional recovery. It has been shown that by the twelfth postoperative week 100% of patients can regain their ROM to within 10° of the uninjured side.[21]

Petri et al. have shown that under cyclic loading suture anchors resisted significantly more gap formation compared with transosseous suture tunnels in a cadaveric model of quadriceps tendon rupture. Gap formation averaged 33.3 mm in the suture tunnel group and 1.9 mm and 1.5 mm for titanium and hydroxyapatite suture anchors, respectively. Load to failure of the titanium anchors averaged 740 N, compared to hydroxyapatite anchors and transosseous sutures that averaged 572 N and 338 N, respectively.[22] In another study of quadriceps tendon rupture in 12 unmatched fresh frozen cadaveric specimens, Sherman et al. compared transosseous tunnel repairs with suture anchor repairs.[23] They utilized three 4.5 mm titanium anchors double loaded with #2 Fiberwire (Arthrex) for their anchor repair and #2 Fiberwire through 2.5 mm drill tunnels for their transosseous technique. Ultimate load to failure was not significantly different between the two groups (mean 286 N for suture anchors and 250.5 N for transosseous tunnels). The load to failure of the anchor repair in this study was much less than seen in other biomechanical evaluations, which may be explained by the smaller (4.5 mm) anchor size or the method of cyclical testing prior to the load to failure. A significant difference favoring the anchor group was found in cyclic testing, with less gap formation and less variability in displacement.

Ettinger et al. compared suture anchor repairs with transosseous repairs in a model of patella tendon ruptures in 15 matched pairs of fresh frozen cadavers.[24] Transosseous repairs utilizing 4 strands of #2 Ultrabraid (Smith & Nephew, Andover, MA) through three drill holes where compared with two 5.5 mm anchors (titanium or hydroxyapatite) loaded with two #2 Ultrabraid sutures. In cyclic loading, the gapping was significantly smaller for the suture anchors. Maximum average load to failure was greatest in the hydroxyapatite anchor repair (689 N) followed by 597 N for the titanium anchors, and 301 N for the transosseous suture repairs. Of note, the mode of failure also varied between the three groups: in the titanium anchor group 5 had an anchor pullout and 5 had a tendon pullout, in the hydroxyapatite group 7 had a suture failure at the anchor eyelet and 3 had a tendon pullout, in the transosseous group 4 had a knot failure and 6 had a tendon pullout.

Given what we know about the increased strength of suture anchors compared with transosseous tunnels, along with their resistance to form a gap at the repair site, the biomechanical benefits would seem to justify this technique in quadriceps tendon repair. Our study, however, was unable to find improved clinical outcomes in the SA group. Furthermore, the rates of complications and re-rupture were similar between the two cohorts. Perhaps with a larger sample size and increased length of follow-up the improved biomechanical profile of suture anchor repairs would become evident. The issue of implant cost, though not addressed in this study, is also pertinent when comparing the two repair methods. Each suture anchor costs approximately $300 USD, compared with a cost of approximately $50 USD for a transosseous repair. If two anchors are used, this results in a cost differential of over $500.

5. Conclusion

With the similar clinical results, operative time, and complications of suture anchor and transosseous repairs in our study, both techniques appear to be viable solutions. Further study of the clinical and functional outcomes of quadriceps tendon repair would benefit from prospective randomized controlled trials.

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