Original Article

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The results of zone 2 Flexor Tendon Repair with Four Strand Cruciate suture Technique

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Abstract

Introduction:The zone 2 flexor tendon injury is a common problem in clinical practice. Although many suture techniques are popular like Kessler, Modified Kessler, Bunnell, Savage, Lee, and Tsuge with their peculiarities none of them meet an ideal suture technique criteria. In this quest of an ideal tendon suture technique, Four Strand Cruciate design appears a strong contender in recent literature. The purpose of this study is to assess functional outcome of zone 2 flexor tendon repairs by Four Strand Cruciate suture design.

Materials & Methods: A consecutive group of patients with zone 2 flexor tendon injuries of hand were repaired with four strand cruciate technique during January 2014 to December 2015. This repair has 4 strands with a cruciate design at the repair site. It is a grasping type with knot coming away from the repair site. The postoperative protocol included Kleinert traction and Modified Brook Army Hospital regimen. Functional outcome was assessed by validated scores like Total Active Motion (TAM), Modified Strickland functional score, Quick DASH score.

Results:Between January 2014 to December 2015, 27 fingers with cut flexor tendons were sutured by this method. Average total activity motion (TAM) at 3 months was 51% and at 6 months it was 63%. At 3 months, by Modified Strickland Grading, 9 fingers rated excellent or good (33.33%) while 18 fingers rated fair (66.67%). At 6 months, 21 fingers (77.78%) rated excellent or good while 6 fingers were rated fair (22.22%). There were no poor results. The average QDASH at 3 months was 24.96 while at 6 months it was 11.59. Three fingers had re-rupture while 6 fingers had adhesions.

Conclusion:The results of flexor tendon repair with this method are up to the mark as compared to present literature with overall good patient satisfaction (QDASH).Four Strand Cruciate with high tensile strength and gap resistance can allow us to use aggressive post repair rehabilitation protocols. Thus the Four Strand Cruciate with its peculiarities causes fewer complications like re-ruptures and adhesions.,

Keywords: *zone 2 flexor tendon injury, Four Strand Cruciate suture design, functional outcome*

Introduction

The zone 2 flexor tendon injury is a common problem faced by an orthopedic surgeon in clinical practice. As these injuries affect functional outcome of joint movement, the functional recovery after tendon injury has been the point of interest since years. The numbers of tendon injuries are on the rise in spite of safety and protection devices in industrializing countries. More over due to increase in population and increase in vehicles, the incidence of tendon injuries are on increase. This usually burdens finances of country and loss of work hours. The commonly encountered tendon injuries are mainly due to injuries with sharp instruments. The best management method of acute tendon injuries is controversial and debated. Although many suture techniques are popular like Kessler, Modified Kessler, Bunnell, Savage, Lee, and Tsuge with their peculiarities none of them meet an ideal suture technique criterias. The tensile strength, Gap resistance, Gliding resistance and stiffness are affected by number of core suture strands, core suture design and location of knot [1]. In this quest of an ideal tendon suture technique Four Strand Cruciate design appears a strong contender in recent literature of McLarney et al[2] , Akoi et al [3,4]. The four strand cruciate technique having 4 strands in cruciate design and knot coming away from repair site is new technique which needs to be assessed in flexor tendon repairs. A UK survey of repair technique in 2014 showed use of Kessler method of 36%, modified Kessler of 28% and use of four strand cruciate only 5% [5] . The use of this method though studied in cadavers show good biomechanical results, clinical results are still not that examined and published in literature. The purpose of this study is to assess functional outcome of zone 2 flexor tendon repairs by Four Strand Cruciate suture design.

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Methods

A consecutive group of patients with zone 2 flexor tendon injuries of hand were repaired with four strand cruciate technique during January 2014 to December 2015. Acute injuries of tendons essentially midsubstance rupture / cut injuries were included. Injuries less than 2 week only were repaired by this technique. The exclusion criteria's were patients with wound infection at the time of presentation,

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associated fractures of underlying bones, patients requiring arterial and nerve repair, patients with psychiatric disorders, head injuries, substance abuse or cognitive deficiency, severe arthritis of joints, crush injuries. Patients with age less than 12 years and more than 75 years were also excluded. Tendon repairs were done under regional anaesthesia in operation theatre under pneumatic tourniquet. Adequate exposure is done to retrieve tendon ends. Tendon repair is done with Vicryl of appropriate number depending on width of tendons. All the tendons were sutured with four strand cruciate design only. This repair has 4 strands with a cruciate design at repair site. It is a grasping type with knot coming away from repair site (Fig 1-6).

Post operative protocol

This protocol involved early active controlled mobilization under supervision. Kleinert traction was applied with sutures passed through nail of affected digit and tied to rubber band. A dorsal plaster of Paris slab applied to prevent extension.

Modified Brook Army Hospital regimen was followed.

- 0-4 weeks – Rubber band passive flexion splint with voluntary active extension of I.P. joints. During active extension exercises patient is instructed to hold M.C – P. joints in flexion and then to fully extend I.P. joints. In this way full excursion of I.P. joints is attained while tendon repair is protected.
- First 2 weeks – passive extension by therapist and passive flexion by rubber band.
- 3rd and 4th weeks – active extension and passive flexion.
- 5- 6 weeks – hourly exercises of active flexion and active extension.

Data pertaining to study was prospectively collected in a standard Proforma for all patients.

Outcome measures were assessed and documented in Proforma includes

1. The primary outcome measure was range of movement across the joint at 3 months and 6 months.
2. Functional outcome was assessed by validated scores Total Active Motion (TAM) Modified Strickland functional score Quick DASH score
3. Operative time – it is defined as time from incision to closure. It was recorded in all patients.
4. Condition of wound, scar and any complications were documented.
5. Total period required for return to job or change in job was documented.

Results and Statistical analysis:

Between January 2014 to December 2015, 42 patients had tendon injuries. Those tendon injuries associated with fractures of underlying bones, arterial and nerve injuries were excluded from the study as they require different postoperative protocol. Only 31 patients fulfilled the inclusion criteria's and were included in the study. Four patients were lost to follow-up during the study and they were excluded from study at the time of final analysis. This left us with 27patients with 27 fingers with cut flexor tendons for evaluation. There were only 3 females while rests 24 were male patients. The ratio of injury in different occupation groups is carpenters – 37.5%, laborers – 25% and others – 37.5%. Eighteen out of twenty seven (66.6%) tendons were injured by knife while 9 tendons (33.4%) were injured in road traffic accidents. The commonest mode of injury was by knife seen in carpenters (33.4%). All the flexor tendon injuries were seen in zone 2 with 55.5% were isolated Flexor digitorum profundus (FDP) and 44.5% were both Flexor digitorum profundus and Flexor digitorum superficialis (FDP/FDS). 88.8% i.e. 24/27 tendons were sharply cut while three were crush injuries from RTA. 66.6% of cases i.e. 18/27 were sharp cut injuries of tendons by knife and are equally distributed in isolated FDP and FDP/FDS groups. 18 cases were right sided while 9 were left sided. Among sharp cut injuries 62.5% were right sided while 37.5% were left sided. Average operative time in different injury patterns of knife and RTA was 35 minutes with S.D. of ± 4.33 min in both groups. Average operative time for repair of FDP rupture was 33.75 min with S.D. ± 4.787 min and for combined FDP/FDS repair it was 36 min with S.D. ±4.183 min. This difference in operative time in both groups was not statistically significant. t value = 0.47; p value = 0.75 ($p > 0.05$) Average total activity motion (TAM) at 3 months was 51% with S.D.± 0.23% and at 6 months it was 63% S.D. ± 0.19%. The average increase in TAM was found to be 12%. At 3 months, by Modified Strickland Grading, 9 fingers rated excellent or good (33.33%) while 18 fingers rated fair (66.67%) At 6 months, 21 fingers (77.78%) rated excellent or good while 6 fingers were rated fair (22.22%). There were no poor results. The average QDASH at 3 months was 24.96 with S.D. ± 10.07 while at 6 months it was 11.59 with S.D. ± 5.61. At the time of final outcome measurement (6 months), there were 21 out of 27 fingers with excellent or good outcome and average QDASH of 9.7. They had average movement i.e. TAM of 71% as compared to normal fingers. Six out of 27 fingers had fair outcome with average QDASH of 18.18 and TAM of 37%. When comparing QDASH at 3 and 6 months in terms of change in TAM, there was reduction of QDASH value to half from 3 months to 6 months. The improvement in TAM occurred in 21/ 27 fingers (78%). 12 were FDS/FDP and 9 were isolated FDP repairs. In them QDASH of 20.67 at 3 months decreased to 9.58 at 6 months indicating good patient satisfaction. The decrease in TAM was seen in 6/27 fingers. The QDASH at 3 months was 32.9% which decreased only up to 13.6 at 6 months indicating less satisfactory functional outcome. In patients with age less than 30 years, 3 months QDASH was 13.6 which decreased to 9.09 at 6 months showing good outcome. While patients of age groups more than 30 years, QDASH was significantly high at 3 months with average

Figure 1: Case 1 FDS/FDP injury of Little Finger

Figure 2: Case 1 ROM -Finger extension

Figure 3: Case 1 ROM -Finger Flexion

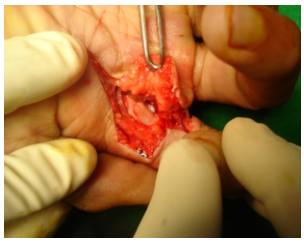

Figure 4: Case 2 FDS/FDP injury Index Finger

Figure 5: Case 2 Post op.

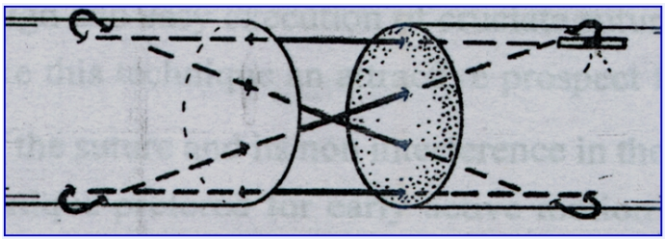

Figure 6: Four Strand Cruciate Design

33.45 and 25.99. QDASH failed to reduce below 10 at 6 months (11.34 & 15.89). Fingers with both FDS/FDP injuries, QDASH at 6 months was 13.63 while in isolated FDP injuries it was 9.98 indicating good results and better patient satisfaction in isolated FDP injuries. Though TAM decreased in 6 cases, QDASH still reduced till 6 months while in 12 cases TAM improved but QDASH failed to reduce accordingly. Considering this variation, objective TAM evaluation and subjective QDASH score are not very much dependent on each other. Only three patients (11.11%) in our series had rupture of tendon repair between 3- 4 weeks. Tendons were again repaired and patients went through postoperative protocol of 6 weeks again. At the end of 6 months they had TAM of 54% and graded fair outcome and average QDASH was 10.54. The 6 digits were rated poor at final outcome. The decreased TAM was found to be due to adhesions in 6 patients. Tenolysis was advised but they refused further treatment. Although both patients continued with their original job, they were not satisfied with outcome.

Discussion

Since last four decades the management of zone 2 flexor tendon injuries is revolutionized due to immediate tendon repair and post repair motion protocols. Over these years many new suture designs, methods has been developed to increase strength and gap resistance of tendon repair techniques. They have permitted more aggressive post repair motion protocols and hence the global improvement in results. In spite of all these advances, there is no consensus over the gold standard or an ideal tendon repair technique. Savage[6] and Strickland [7] observed that the strength of tendon repair is proportional to the number of suture strands that cross the repair site. It has initiated a departure from 2 strand core sutures which were clinically dominant until 1990. A number of 4 strand, 6 strand methods have been described in recent literature of Strickland and are in clinical use. Instead of these recent advances, the debate continues about techniques with high tensile strength and gap resistance. The core suture design which influences breaking mode of repair is highly investigated and debated about. The dilemma continues about gliding resistance and location of knot. The surgeon has to decide about the locking or grasping type of design so as to reduce gliding resistance without reducing tensile strength till tendon heals without adhesions. These all points make selection of repair technique more difficult. A four strand cruciate design for tendon repair as described by McLarney [2] and Strickland [7] seems to be the near ideal suture technique. A review of literature shows lack of comprehensive clinical study of zone 2 flexor tendon repair with four strand cruciate suture technique. Hence this study was performed. Elliott et al [8] reported 79.4% good or excellent results in zone 2 flexor tendon repair with Kessler repair. Sandow [9] reported 78% excellent or good results with four strand technique while Chow et al [10] reported 80% excellent results with four strand cruciate technique. Alice et al also reported improved results with this technique in rabbit models [11]. In our study, at 6 months we had 77.78% excellent or good results (21/ 27 fingers) while 22.22% had fair results (6/27 fingers). Result of our series were at par with present literature with average QDASH for excellent or good group was 9.7 and for fair or poor group was 18.18 indicating good patient satisfaction. But at 3 months, 18/27 fingers had fair outcome (66.67%) while only 9 fingers were having good results. These figures drastically changed by 6 months. Out of 18 fingers with fair outcome 12 fingers improved to good outcome due to improvement in TAM. This change was mainly due to continued physiotherapy and active motion during initial 4 weeks. The good results from western literature have the cases of flexor tendon repair done exclusively by skilled superspeciality hand surgeons with

facilities of operating microscope. They also have dedicated skilled hand physiotherapist for individual follow up. The lack operating microscope and dedicated hand therapist can be accountable for our fair outcome at 3 months in zone 2 flexor tendon repair. Elliott reported 4 – 7% of rerupture rate while Chow reported 3 – 8.4%. We had only 3 case of rerupture accounting to be 11%. In Chow series 16% cases required tenolysis for adhesions while in our series 22% i.e. 6 cases had adhesions. As we used aggressive Modified Brook Army Hospital regimen for rehabilitation our results were satisfactory and comparable with western literature. The locking designs are known for more gliding resistance and adhesions than grasping types as demonstrated by Akoi [12]. Raquel [13] noticed better biomechanical results in four strand cruciate technique in animal tendons . MH Yuen [14] concluded this technique safe in oblique lacerated tendons as grasping point moves away from lacerated portion which improves ultimate tensile strength .The location of knot in four strand cruciate is away from the repair site. This helps in decreasing bulk at repair site and assuring perfect apposition of tendon ends. But as knot comes on tendon surface it is of concern that it will increase gliding resistance and friction leading to adhesions especially in zone 2 flexor tendon repair. More over 4 grasping sutures on surface may make this design more prone for adhesions.

Conclusion:

The purpose of this study was to assess functional outcome of zone 2 flexor tendon repairs done with Four Strand Cruciate technique. The results of flexor tendon repair with this method are up to the mark as compared to present literature with overall good patient satisfaction (QDASH). Four Strand Cruciate has significant high tensile strength and gap resistance than other two strand techniques which can allow us to use aggressive post repair rehabilitation protocols. Thus the Four Strand Cruciate with its peculiarities causes fewer complications like reruptures and adhesions. The ease of placement and less time for repair with above properties make it near ideal tendon repair technique. There is no significant correlation between tendon ends, operative time and functional outcome of tendons repaired. There are significantly good results in patients less than 30 years with respect to functional outcome. This technique gives confidence to the surgeon to start with aggressive rehabilitation protocols to achieve good functional results. The incidence of complications like reruptures, adhesions is very less. On the whole, though overall results are good, we recommend caution while using this technique for zone 2 flexor tendon repair as more detailed studies with longer follow up are required before accepting it as a standard technique for flexor tendon repair by a general orthopedic surgeon.

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