Research Article

Tendon Repair and Outcome Audit

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Abstract

Introduction: Tendon repair is one of the commonest procedures performed in the hand surgery. This repair is associated with two major complications of tendon rupture and tendon adhesions. We have reviewed the results of our technique of tendon repair and compared the results with international standards.

Methods: This is a retrospective review of prospectively maintained data at department of Plastic Surgery at Countess of Chester Hospital UK, from 1st June 2010 to 1st June 2011. All patients who underwent tendon repairs were included. We devised a proforma to standardize the information collection. Parameters studied included mode of trauma, zone of injury, average number of tendons involved, and rate of complication of tendon rupture and stiffness.

Results: A total of 108 procedures were done for tendon injuries, of which 56% were flexor tendons and 44% were extensor tendons. Glass injuries account for the majority of cases, both for flexors and extensors. Average number of tendons involved per injury was 2 for flexors and 1.5 for extensors. The most commonly used technique of repair was 2-strand modified Kessler with continuous epitendinous suture. We observed a 5% rate of rupture and 6.5% of stiffness for flexor tendons and 4% of rupture and 2% of stiffness rate of extensor tendons.

Conclusion: 2 strands modified Kessler repair with 4/0 Proline in small size tendons and 3/0 Proline in large size tendons with 6/0 Proline over and over continuous epitendinous suture is a good technique for tendon repair.

Keywords | tendon injury, modified Kessler repair, tendon rupture

Received | 17-12-2019: **Accepted** | 16-09-2020

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Introduction

Different surgeons have always shown a variety of techniques for tendon repair to achieve problem free healing. Rupture, adhesion and reoperation arecommon problems encountered after tendon repairs.[1-2] Refinements of current techniques are always sought to improve the results. Although most commonly employed technique in flexor tendon repair is modified Kessler repair, there are a number of other techniques popularized by different people throughout the world. We have evaluated our unit's one-year record of tendon repair and compared it with the results of different other techniques. The preferred technique of the senior author for flexor tendon repair is 2 strand modified Kessler repair with 4/0 Proline in small sized tendons and 3/0 Proline in large size tendons and 6/0 Proline continuous over and over running epitendinous repair. We set this technique as standard for us. All cases received standard physiotherapy of early active mobilization. We aim to assess the results of this standard technique with respect to rupture rates and stiffness, and compare this with the standard rates.[2]

Methods

We did a retrospective review of prospectively maintained data of all patients undergoing extensor or flexor tendon repair at our unit in a 12-month period from 1st June 2010 to 31st May 2011.We devised a proforma to standardise the collection of information from the operative and hand therapy notes on the charts of each patient treated during this time. All relevant demographic information was recorded. The parameters studied included method of injury, average delay from injury to presentation, zone of injury and pulley involvement. Rate of complications of rupture and stiffness were assessed at follow-up visits

Results

Over 1 year, a total of 108 tendon repairs were performed. Of these 56% were flexor tendons and 44% were extensors tendons. Mean age at presentation was 34.5 years (flexor) and 36.7 years (extensors). Average delay from injury was 1.7 days and 1.8 days for flexors and extensors respectively (Table 1).

Common mechanisms of injury are depicted in table 2. Glass injuries are the most common cause of both flexor and extensor tendon injuries.

The average number of tendons injured and digits involved per injury is shown in table 3. For flexor tendons, Zone 2 injuries were most common. In the case of extensors, all zones seem to be equally involved (Table 4). Per-operative findings relating to the injury (amount of tendon injured and involvement of pulley) are shown in table 5.

The most commonly used technique was 2 strands modified Kessler core stitch using 3/0 or 4/0 Prolene (Table 6 & 7) and continuous over and over epitendinous suture with 6/0 Prolene.

Majority of the patients complied with post-operative splint usage and physiotherapy. The details of post-operative follow-up are depicted in table 8.

There was a 5% of rupture rate and 6.5% of stiffness for flexor tendons and 4% of rupture and 2% of stiffness rate of extensor tendons (Table 9).

Discussion

If one asked a patient what he or she considers an excellent result after repair of a flexor tendon, the answer would be return to normal. We are happy to call the result ”excellent” when they are 85% normal. Using modern suturing and rehabilitation, we mostly

Table 1: *Tendons Involved, Mean Age and Mean Delay since Presentation*

	Flexor Tendon	Extensor tendon
No. of patients	61	47
Mean age (years)	34.5	36.7
Average delay since injury (days)	1.7	1.8

Table 2: *Method of Injury*

Method	Flexor Injuries	Extensor injuries
Glass	23	18
Metal	24	11
Saw	7	12
Ceramic	1	1
Punch	0	1
Drill	0	1
Crush	2	0
Axe	1	0
Not detailed	3	3

Table 3: *Number of Tendons and Digits Injured*

	Flexor Tendons	Flexor Digits	Extensor tendon	Extensor Digits
Min	1	1	1	1
Max	10	4	6	4
Ave	2	1.4	1.5	1.4

Table 4: *Zone of Tendon Injury*

Zone	Flexor	Extensor
1	10	4
2	26	8
3	1	9
4	2	2
5	13	7
6	x	6
7	x	3
8	x	2
Multiple Zones	6	5
Not documented	3	1

Table 5: *Injury Parameters*

Injury	Flexor injury	Extensor injury
Amount of tendon injured	46	33
Complete	14	13
Partial	1	1
Not documented		
Involvement of pulley		
Yes	12 (1 repaired, 11 vented)	N.A
Not documented	49	

Table 6: *Core suture type*

Repair	Flexor repair	Extensor repair
Kessler	8	1
Modified Kessler	40	24
Mattress	0	10
Cruciate	0	4
Continuous	2	4
Bunnell	1	0
Not Documented	10	4

Table 7: *Number of core suture strands*

Strands	Flexor Tendon	Extensor Tendon
2	19	12
4	5	7

Table 8: *Post-operative management*

	Flexor injury	Extensor injury
Splint used		
Yes	53	37
No	7	8
Not documented	1	0
Hand Physiotherapy duration (weeks)		
Minimum	0	1
Maximum	29	15
Average	7	6.6

Table 9: *Complications*

	Flexor injury	Extensor injury
Rupture	3	2
Stiffness	4	1
Stiffness and rupture	2	1
Tenolysis required	1	1
2 stage repair required	2	0

achieve, at the best, around 70-80% good and excellent results, with 10% of cases failing to achieve this because 5% rupture and 5% become adherent to the surroundings.

Over and above the technical difficulties of this surgery, the problem of tendon rupture and tendon adhesions are the major difficulties in the field of surgery[1]. Healing of flexor tendon takes about two to three months, which is sometimes longer than the period for which generally people refrain the hand from using, so the tendon repair snaps. The second problem of adhesions occurs because the body creates edema in any area of healing and the fibrin-filled edema fluid behaves like a soup of glue. While it works well to heal the structures, it leads to scar adhesions. This can affect the flexor tendons anywhere along their length to either reduce their excursion and reduce the range of motion of the digit, or, in 5% of cases, completely prevent any movement at all. This odema is marked more on the dorsum of hand than on the volar surface. This extensor adhesion prevents digital flexion because the extensor tendon cannot glide distally as the flexor tendons attempt to pull the digits into flexor. This extensor tethering, in conjunction with tightening of the dorsal capsule of the joints, is the main cause of poor results after primary flexor tendon surgery, although flexor tendon tethering can contribute.

Since longtime, surgeons has been trying to create a system which allow us to keep tendon repairs moving after surgery, to prevent adhesions. Because early movement may lead to rupture and defeat the aim, there has also been a need to create a suture and technique strong enough to allow this movement.

Flexor tendon repair contains core sutures and circumferential epitendinoussutures. Strickland[2], 3listed characteristics of an ideal primary flexor tendon repair as:

- Suture easily placed in the tendon
- Secure suture knots
- Smooth juncture of tendon ends
- Minimal gapping at the repair site
- Minimum interference with tendon vascularity
- Sufficient strength throughout healing to permit the application of early motion stress to the tendon.

A variety of suture materials have been used over the years but no best suture has ever been identified. The thickness of the suture has been investigated periodically. However, there is little one can vary; there is no doubt that finer sutures will snap more easily but thicker sutures are too big for the purpose of flexor tendon suture. So, a compromise of 3/0 core suture for larger tendons and 4/0 core suture for smaller tendons is the general rule.

Different people have described various core suture techniques over the years to achieve the above-mentioned aims (Figure 1). Tajima and Strickland variations of the Krichmayer/Kessler[4,5] suture, in which the knot or knots are buried in the tendon, are probably the most commonly used core suture technique in the Europe. The Tasuge suture, or Tang's[6] triple variation of it, is the most likely to be used in the Far East. As most of the published series of Zone 2 repairs in civilian population from all over the world have roughly the same results, it would seem that most materials and most core suture techniques in common use work equally well.

It is clear that we need strength of 9-15 Newtons in our tendon repairs to allow us to use the Klienert 9-12 and Belfast[13-15] techniques of mobilization. However, if we want to prevent rupture in patients who use the hand early after repair then our sutures may need to resist 50 Newtons.

It has also been proven by the Laboratory work that Savage and Rissitano[16] 6 strand Kessler type of suture remains the strongest core suture we have but it is very difficult to use clinically, for which reason it is widely avoided in the clinical practice. Much of the work subsequently has been in trying to devise simpler multi-strand core suture technique, which is more practical, while retaining the strength advantage of the original Savage Rissitano suture.

The original aim of the epitendinous suture was to smooth down loose ends of the repaired to tendon in order to enhance gliding.[17-21] In 1986, Wade[22] realized that it also adds to the strength of the repair. In 1988, Lin and his colleagues[23] described the first strengthened epitendinous suture. This has led to about 5-6 variants being described over the last two decades with several laboratory trials on them (figure-2). These broadly show that a continuous suture, which is still commonly used, is the weakest of theses sutures, and certain innovative techniques of epitendinous sutures are comparable in strength to the core suture. In a laboratory study in 1996, Manske's team[24] studied tendons repaired solely with epitendinous sutures and recorded surprisingly high breaking strengths of up to 63 Newton. These newer techniques employ multiple gripping bites through the tendon, which is not unlike core sutures in principles, and they may be eight, ten or more of them. So we have another suture to use, not as a contender or alternative to the core suture as originally thought, but as a way of augmenting it. However, this study also showed that the more material there is on the surface of the tendon, the more friction there is on mobilization. So there is probably an upper limit to how much we can elaborate the epitendinous suture.

Many surgeons have advocated repair of the flexor tendon pulleys after tendon repair. Gelberman et al,[25-29] Lister,[30-32] Peterson et al,[33] Saldana et al,[34] Tang[35-37] and colleagues, and Tonkin[38] studied the advantages and disadvantages to flexor sheath repair. however, their work fails to provide any clear conclusions regarding pulley repair. The theoretic advantages of sheath repair are prevention of formation of extrinsic adhesions, and more prompt return of synovial nutrition, therefore resulting in better tendon–sheath biomechanics. The disadvantages are that it is often technically demanding, and that the repair results in a narrow passage that hinders tendon gliding. Duran and Houser[39] suggested partially releasing one side of the pulley on which a repair was catching. Strickland elaborated on this technique, introducing the term 'venting' the pulley, meaning cutting the side of it. There is still reluctance to allow venting of pulleys, especially A2 and A4, as these are important in preventing bowstringing, and in maintaining the mechanical efficiency of the flexor system. This belief takes origin from the fact that in doing secondary flexor tendon surgery, the minimum one need to preserve in flexor tendon reconstruction was an A2 and an A4 pulley. This practice was brought into primary flexor tendon surgery, that these two important pulleys must be preserved entirely. More recent research has demonstrated that there is no absolute need to preserve the A2 or the A4 pulley so completely, provided that the remaining sheath is intact.

Summary of the tendon management:

- Common trauma presentation
- Multiple flexor tendon injuries
- Core Suture 3-0 or 4-0 Proline as suitable
- Paratenon repair with 6/0 Proline as suitable
- Vent Pulleys on Radial aspect
- Referral to Hand Therapy on Discharge

Conclusion

We concluded that 2 strands modified Kessler repair with 4/0 Proline in small size tendons and 3/0 Prolene in large size tendons with 6/0 Proline over and over continuous epitendinous suture gives comparable results to other tendon repair techniques.

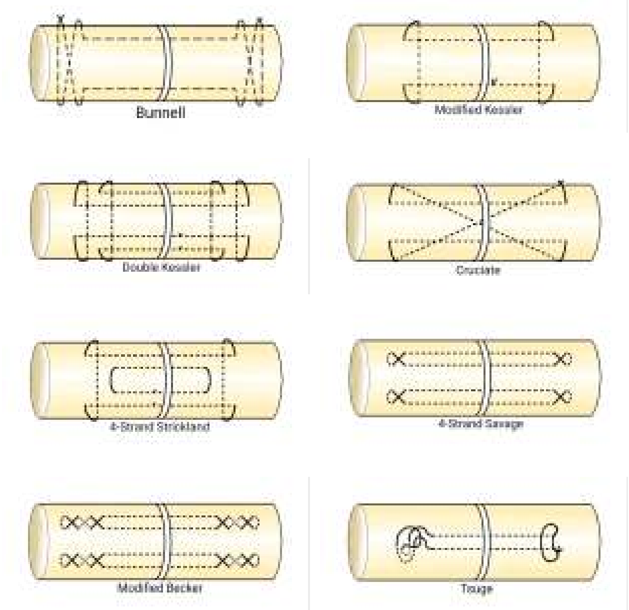

Figure 1: *Types of Tendon Repairs*

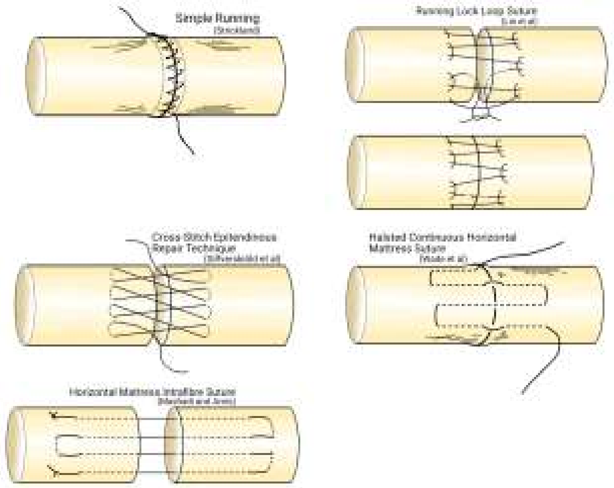

Figure 2: *Peripheral (Epitendinous) Tendon Suture Techniques*

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