ORIGINAL ARTICLE

COMPARISON OF OUTCOME OF 1- AND 2-KNOT, 4-STRAND, DOUBLE-MODIFIED KESSLER FLEXOR TENDON REPAIR WITH EARLY ACTIVE MOBILIZATION PROTOCOL IN PATIENTS WITH FLEXOR TENDON LACERATIONS OF HAND

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Background: Hand is unique for the dexterity of its function and flexor tendons have most important function in hand. Its injury is a challenging treatment. Purpose of this study is to compare the success of 1- and 2-knot, flexor tendon repair (good to excellent results) with early active mobilization in terms of total active motion (TAM) of affected hand postoperatively. **Methods:** Hundred patients with age range of 5–70 years of age presenting with flexor tendon lacerations of hand were included in the study. Subjects were randomly divided into Group A, who underwent flexor tendon repair using 4 strands of double modified Kessler repair with 1 knot and Group B, in which 4 strand double modified Kessler repair with 2 knot technique was used. All patients followed early active motion protocol started in first 48 hours. They were followed at 3, 6 and 8 weeks after surgery for TAM. Data was entered and analysed in SPSS-21.0. Frequency and percentages were calculated for outcome of procedure. **Results:** In group A 89.8% (44) of patients had good to excellent results in terms of total active motion (TAM) as compared with 90.9% (40) in group B using early active mobilization protocol. **Conclusion:** The study concluded that that four strand double modified flexor tendon repair using either 1 or 2 knot technique are excellent choices of repair with early active mobilization protocols.

Keywords: Flexor tendon injuries; 4 strand repair; Total active motion; Early active mobilization

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INTRODUCTION

Flexor tendon injury is a complex problem to manage. Inappropriate treatment can lead to loss of function and long-term disability. Multiple techniques of flexor tendon repair are described in literature.[1]

Before 20th century most flexor tendon repairs were followed by immobilization of hand for 3–4 weeks because of decreased tensile strength at 3 weeks. But recent studies have shown benefits of early mobilization after tendon repair with increased tendon excursion strength and decreased adhesion formation.[2,3] Early controlled mobilization also prevents joint contractures. So now postoperative rehabilitation is started soon after flexor tendon repair. But it has down side of gap formation or tendon rupture.[4]

In 2009, comparison study of single knot verses double knot in fours strand repair showed that 1-knot technique is significantly stronger than 2-knot technique. Rees Leila *et al* demonstrated that mean failure load for the 1- knot and 2-knot repair samples were 98.9 N (SD 16.0) and 85.1 N (SD 14.0) respectively.[5] The primary goal of the flexor tendon repair is to perform a repair which is strong, and can withstand early active rehabilitation. There is no significant difference in adhesion formation after 2 or 4 strand tendon repairs. While Gap resistance and tensile strength of 4-strand repair is greater than 2 strand repairs6. In this study we compared 1 knot and 2 knot flexor tendon repairs in patients presenting with flexor tendon laceration, using 4 strand double modified Kessler repairs, with knots placed between the tendons ends. Postoperative early active mobilization was carried out.

MATERIAL AND METHODS

After ethical approval study was conducted at Department of Plastic Surgery, Jinnah Burn and Reconstructive Surgery Centre Lahore from Nov 2015 to Nov 2017. 100 cases were enrolled and divided into two groups (50 in each group). Sample size was calculated with 80% power of test, 1% level of significance and taking expected percentage of outcome (in terms of good to excellent results) 97% in 1 knot group and assumed percentage 70% in 2 knot group in patients with flexor tendon lacerations of hand through a non-probability consecutive sampling. Subjects with age range of 5–70 years of either gender with flexor tendon lacerations of hand were included in our study. All injuries with associated extensor tendon lacerations, fractures or vascular injuries were excluded. After an

Informed written consent subjects were divided randomly by the help of lottery method. Repair was done by four core sutures of 4/0 polypropylene by double modified Kessler technique with single knot (Group A) or double knot (Group B) placed between tendon ends. This was supplemented by a circumferential epitenon running suture of 6–0 polypropylene. Splint was applied with wrist 30-degree flexion, the metacarpophalangeal joints at 30-degree flexion and interphalangeal joints straight. All patients followed early active motion protocol started in first 48 hours. They were followed at 3, 6 and 8 weeks after surgery for TAM. Data was entered and analysed using SPSS version 17. Frequency and percentage were calculated for outcome in terms of TAM. Chi square was used to compare the success in both groups (good to excellent results). The *p*-value <0.05 was considered as statistically significant.

RESULTS

100 subjects were recruited for the study. Mean age was 29.85 SD 13.237, minimum age was 11 years and maximum age was 67 years. 70.0% were between ages of 10–40 years. 78.0 % were males, 43.0% fall in zone 4, 30.0% injuries were in zone 2. 48.0% affected tendon was FDS, 45.0% was FDP. 84.0% had successful outcome. 7.0% of subject were lost to follow up. (Table-1). 89.8% had success in Knot1 technique and 90.9% had success in knot 2. Results were statistically insignificant. ($X^2 = 3.873$ $p = .144$) (Table-2)

Table-1: Demographic and clinical profile of subjects:

Variables n= 100	**Frequency**	**Percent**
Age Mean = 29.85 SD 13.237 Min = 11 years Max = 67 years		
10 – 40	70	70.0
41 – 70	30	30.0
Gender		
Male	78	78.0
Female	22	22.0
Zone of injury		
Zone 2	30	30.0
Zone 3	9	9.0
Zone 4	43	43.0
Zone 5	18	18.0
Affected tendon		
FDS (Flexor Digitorum Superficialis)	48	48.0
FDP (Flexor Digitorum Profundus)	45	45.0
FPL (Flexor Pollis Longus)	4	4.0
FCR (Flexor Carpi Radialis)	1	1.0
FCU (Flexor Carpi Ulnaris)	2	2.0
Success in term of good to excellent results		
Yes	84	84.0
No	9	9.0
Result cannot be assessed (lost to follow-up)	7	7.0

Table-2: Success in term of good to excellent results * Flexor tendon repair technique cross tabulation n=93

Success in term of good to excellent results	**Flexor Tendon Repair Technique**		**Total**	**Chi-square**
	1 Knot Technique	**2 knot Technique**		***p*- value**
Yes	44	40	84	$X^2 = 3.873$ $p = .144$
	89.8%	90.9%	90.3%	
No	5	4	9	
	10.2%	9.1%	9.7%	
Total	49	44	93	
	100.0%	100.0%	100.0%	

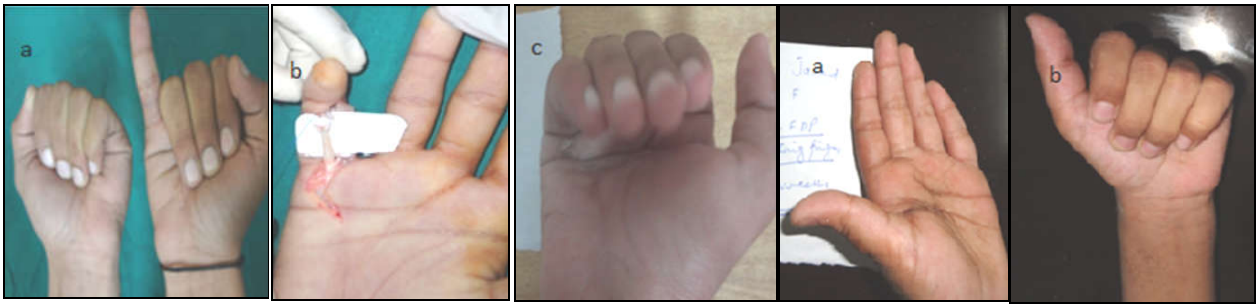

Figure-1: a. FDS, FDP injury little finger. b. intra-op picture with 1-knot technique. c. 5-week follow-up. a (2nd case) FDS, FDP injury ring finger b. 6 week follow up after 2-knot technique

DISCUSSION

Flexor tendons repair rehabilitation by early active mobilization promotes tendon healing, increase tensile strength and prevents formation of adhesions and rupture.[7,8] The successful results range from 70–100% in studies by Cullen[9], Chow[10] & Silfverskiold[11].

Repaired tendon is at its weakest tensile strength approximately one week after the repair. Most tendon ruptures occur during the first 3 weeks following the procedure. Twenty good results are achieved in literature with Kleinert's active extension–passive flexion mobilization protocol but poor differential gliding was observed between the superficialis (FDS) and pro-fundus (FDP) tendons. This differential gliding between flexor tendons can't be achieved with passive mobilization due to buckling of tendons.[1,12]

Differential gliding between the flexor tendons is contributed by Active flexion or mobilization of the fingers. Additionally, active muscle contraction promotes recovery of muscle tone and strength. Load applied after the tendon repair during active finger flexion improves the subsequent tensile strength with healing. A mean of 85% to 95% of patients achieved excellent to good results in both groups.

Grip strength & range of motion continues to improve after tendon repair till one year. Outcome of early active rehabilitation will not be successful in weak repairs like two strands Kessler repair technique, with the rupture rate up to 9.4%.[13] This rate can be significantly reduced with stronger repair techniques.

Quite often subclinical dehiscence occurs instead of rupture of tendons, resulting in gradual loss of flexion of finger. In this situation it becomes difficult to distinguish from adhesion formation. In literature biomechanical evidence suggests that two strands kessler repair technique is not strong enough for early active motion when used alone. 4 strand repair is stronger technique which allows early active mobilization to take place, with less incidence of tendon rupture, (None in our study).

CONCLUSION

Four strand modified Kessler flexor tendon repair using 1 knot and 2 knot is an excellent technique because of greater strength, less chances of gapping. It can very well sustain early active motion protocol resulting in good functional outcome. There is no significant difference between 1 or 2 knot techniques.

AUTHORS' CONTRIBUTION

AMM: Collection of data of patients, pre and post op rehabilitation. MS: Collection of data of patients, pre and post op rehabilitation. SA: Collection of all data of patients, pre and post op rehabilitation. FAH: Surgical procedure done. MYM: Surgical procedure done. MAY: Data analysis of patients results. ZUA: Compilation of results and coordination with physiotherapy department for rehabilitation. MNT: Chief consultant surgeon to perform majority of surgeries and overall assessment of final outcome

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