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A prospective study of traumatic extensor tendon injury of hand and its management and outcome.

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Abstract:
Background*: An accurate diagnosis and optimal treatment of extensor tendon injury of the hand and wrist are essential because these injuries are commonly observed in working population of community. A careful clinical history and assessment, knowledge of the mechanism of injury, surgical technique, and the physiopathology of tendon healing is important for good clinical outcome.*
Materials and Methods*: In this hospital based prospective study, 32 patients of extensor tendon injury (ETI) belonging to age group of 15-60years undergoing extensor tendon repair under general/regional anaesthesia were included after inclusion and exclusion criteria.Three technique were applied for repair (modified Kessler, modified Bunnell, modified Becker). Non-absorbable monofilament (Prolene) suture was used. After the repair, wound was closed with fine, interrupted non-absorbable suture. Sterile dressing was then applied along with a volar splint extending from proximal phalanx to proximal forearm. Wrist held in 30° extension and metacarpophalangeal (MP) joints flexed at least 45° and interphalangeal (IP) joints free to mobilize.First post-operative dressing was done on the 5th day. Stitches were removed on 10th and volar splint was changed with wrist held in 20^{0}extension, metacarpophalangeal (MP) joint flexion at 30° and interphalangeal (IP) joints free to mobilise.*
Controlled active mobilisation was begun on the 1st post-operative day. The patient was instructed to carry out two exercises actively: (1) combined IP and MP joints extension and (2) MP joint extension with IP joint flexion. Volar splint was removed on 3rd week. First follow-up was done after 3 weeks, then after 4 weeks. Further follow-ups were done at 2 weekly intervals for 3 months.Clinical results were assessed according to Miller's criteria based on total extension lag and total flexion loss.
Results*: Tendon injuries were more often found in persons at their working age. In the present prospective study, 75% of the patients were between age group of 20-60yrs. Maximum number of patients were in 3rd and 4thdecade of life. In our study 94 % patients sustained injuries to the tendons by sharp objects, followed by blunt trauma seen in 6 % patients. In the present series we used the classification of Kleinert and Verdan. The most common site of injuries was in zone V (25%). Our study reveals that all the patients with zone VIII and IX achieved excellent results while lesions involving digits had variable results. Core suture technique does not affect the result of this study.*
Conclusion: *Tendon repair with modified Kessler's technique are technically easy to perform with a relatively short learning curve. Tendons should be repaired preferably primarily.Strong, meticulous repair is required for good clinical result. Post-operative early controlled mobilization provides better rehabilitation in extensor tendon injuries. The motivated and educated patients may be put on active motion protocols. Regular follow up is advisable in third and fourth week, and then next week, then every 2 weeks for at least three months for clinical assessment.*
Key Word*: Extensor tendon, splint, extension and flexion lag*

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I. Introduction

Extensor tendons are superficially located with minimal amount of subcutaneous tissue that predisposes the extensor mechanism to more complex tendon injuries. Knowledge of anatomy, physiopathology and strict atraumatic surgical technique and a well-planned postoperative programme of extensor tendons are essential for a diagnosisand good clinical outcome of extensor tendon injuries (ETIs).

Injuries of hand are quite common in working age group population and extensor tendon injury is a common hand injury occurring in young individuals. There are two tendon system, extensor and flexor tendon systems having a complex arrangement to give a precise balance of force and positioning of the fingers; therefore, an meticulous repair and reconstruction of extensor tendon should always be attempted to avoid functional sequelae[1].

Classification of injury and anatomical zones are important points to select the appropriate treatment for ETI. Depending on the anatomical zone and on the characteristics of the injuries, ETI can be managed conservatively or surgically. Many surgical techniques have been proposed over the time. Despite recent research findings, a lack of evidence-based knowledge is still observed in surgical treatment and postoperative management of ETI. Further clinical and biomechanical investigations would be advisable to clarify this complex issue.

Fig: Classification of injury and anatomical zones

The old treatment protocol for ETI included static splinting and immobilization for a mean of 6 weeks, followed by a standard rehabilitation. In the last decades, biomechanical evidence urged on a surgical approach using strong and more effective suture methods[2,3,4,5,6].Because of this operative approach, surgical outcomes have significantly improved over the time in most cases.[5,6,7]

II. Material and Methods

This prospective study wasconducted on all patients of extensor tendon injury of hand fulfilling inclusion and exclusion criteria, getting admitted to RIMS hospital, Imphal. A total 32 adult subjects (both male and females) of age 15-60 years were included in this study.

Study Design: Hospital based observational study

Study Location: This was a tertiary care teaching hospital-based study done in Department of Plastic Surgery, at RIMS,Hospital,Imphal, Manipur, India.

Study Duration:from Dec 2017 to Nov 2019

Sample size: 32 patients

Sample size calculation: The study was done on all the patients with extensor tendon injury of hand in the Department of Plastic Surgery, RIMSHospital, Imphal.

Subjects & selection method: The study population was drawn from consecutive patients who presented to RIMS, Hospital with extensor tendon injury of hand or wrist.

Patients were divided into three groups according to technique of repair.

Group A (N=18 patients /35 tendons) -Modified Kesslertechnique

Group B (N=9 patients /24 tendons) -Modified Bunnell technique

Group C (N=5 patients / 15 tendons)- Modified Becker technique

Inclusion criteria:

1.Age – 15 to 60 years

Exclusion criteria:

1. Age - <15 yearsor > 60 years.
2. Co-morbidities – diabetes mellitus, chronicsmoker, rheumatoid arthritis.
3. Bone fracture
4. Associated flexor tendon injury.

Procedure methodology

A detailed history and physical examination of patient were recorded. All routine investigations were done. The supportive and prophylactic treatment in the form of analgesics, antibiotics, anti-tetanus injection, intravenous fluids, and matched blood transfusion, wherever required, were given. Injured hand was radiographed to know any associated bony injury. Patients were subjected to general anaesthesia/regional anaesthesia. Atraumatic technique was adhered to throughout the operation. Non-absorbable monofilament (Prolene) suture was used. Group A(N=18 patients /35 tendons) were repaired withmodified Kesslertechnique, Group B (N=9 patients /24 tendons) were repaired withmodified Bunnell technique andGroup C (N=5 patients / 15 tendons)repaired withmodified Becker technique.


After the repair, wound was closed with fine, interrupted non-absorbable suture. Sterile dressing was then applied along with a volar splint extending from proximal phalanx to proximal forearm. Wrist held in 30° extension and metacarpophalangeal (MP) joints flexed at least 45° and interphalangeal (IP) joints free to mobilize first post-operative dressing was done on the 5th day. Stitches were removed on 10th and volar splint was changed with wrist held in 20^{0}extension, metacarpophalangeal (MP) joint flexion at 30° and interphalangeal (IP) joints free to mobilize.

Controlled active mobilization begun on the 1st post-operative day. The patient was instructed to carry out two exercises actively: (1) combined IP and MP joints extension and (2) MP joint extension with IP joint flexion. Volar splint was removed on 3rd week. First follow-up was done after 3 weeks, then after 4 weeks. Further follow-ups were done at 2 weeks intervals for 3 months.

Clinical results were assessed according to Miller's criteria based on total extension lag and total flexion loss.

Result	Total Extensor Lag	Total Flexor Loss
Excellent	0°	0°
Good	≤10°	≤20°
Fair	11°–45°	21°–45°
Poor	>45°	>45°

Statistical analysis

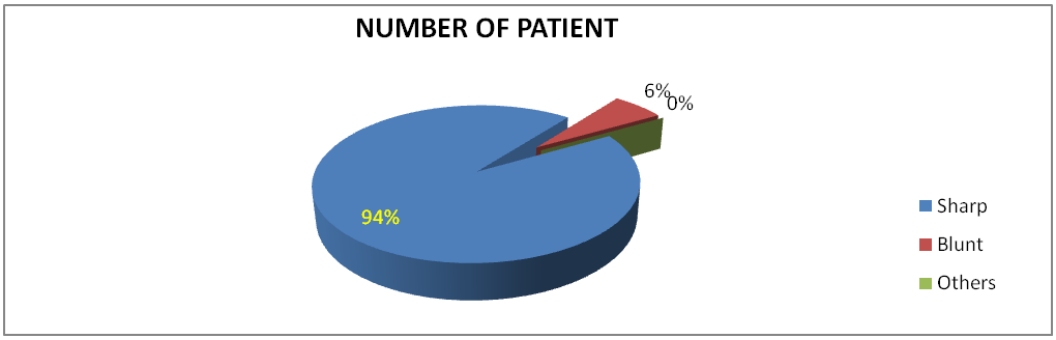
Data was analyzed using SPSS version 2.0 (SPSS Inc., Chicago, IL). Student's *t*-test was used to ascertain the significance of differences between the result of different technique used for tendon repair. The level $P < 0.05$ was considered as the cutoff value or significance.

III. Result

Total number of patients admitted in plastic surgery ward was 1596.
Total number of case of hand injury that came to emergency room was 276.
Total number of cases of ETI after application of inclusion and exclusion criteria was 32.

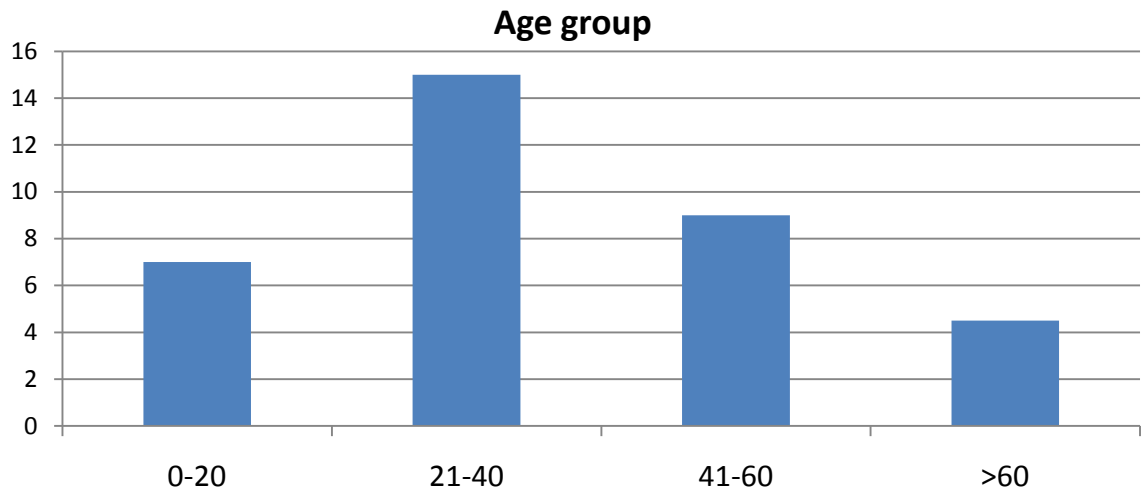
Mode of injury:

Mode	Number of patients	%
SHARP OBJECT	30	93.75
BLUNT TRAUMA	2	6.25
OTHERS	0	



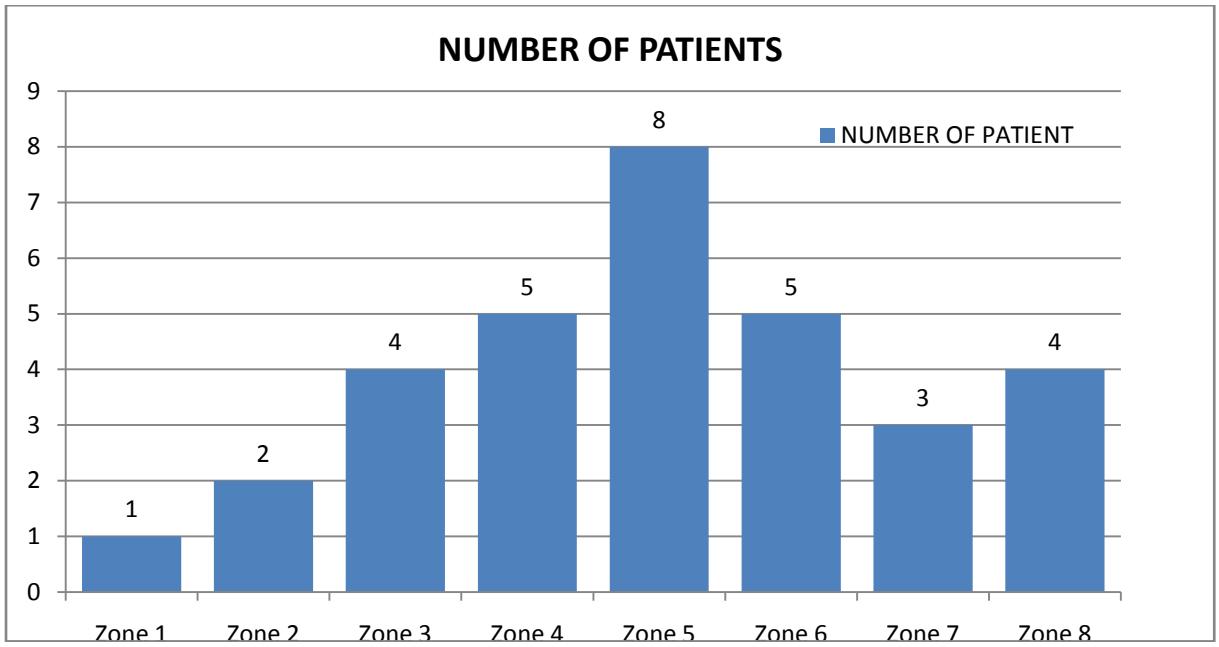
Age:

Age group	Number of patients
0-20yrs	7
20-40yrs	15
40-60yrs	9
>60yrs	1



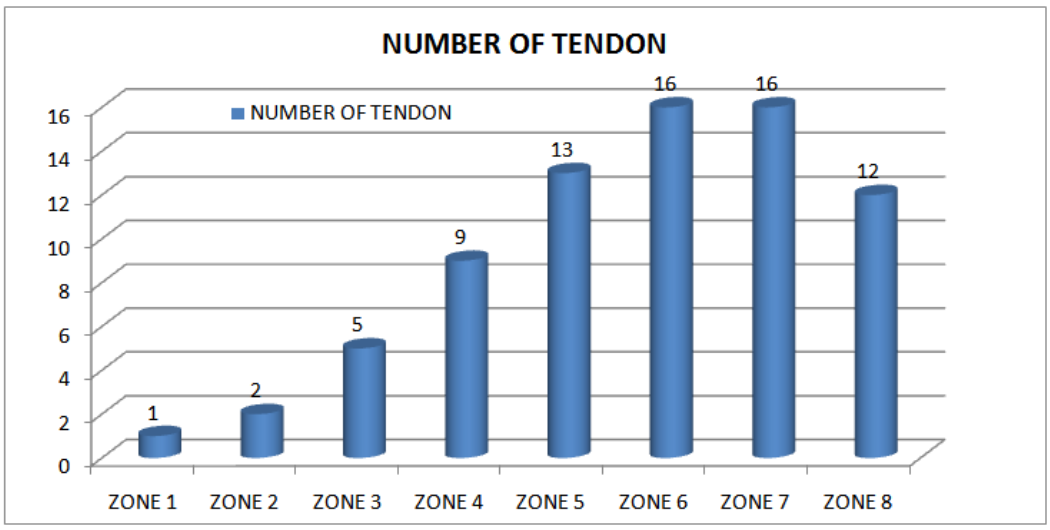
Zone of injury

ZONE	NUMBER OF PATIENT	%
I.	1	3.12
II.	2	6.25
III.	4	12.5
IV.	5	15.6
V.	8	25
VI.	5	15.6
VII.	3	9.37
VIII.	4	12.5
TOTAL 32		



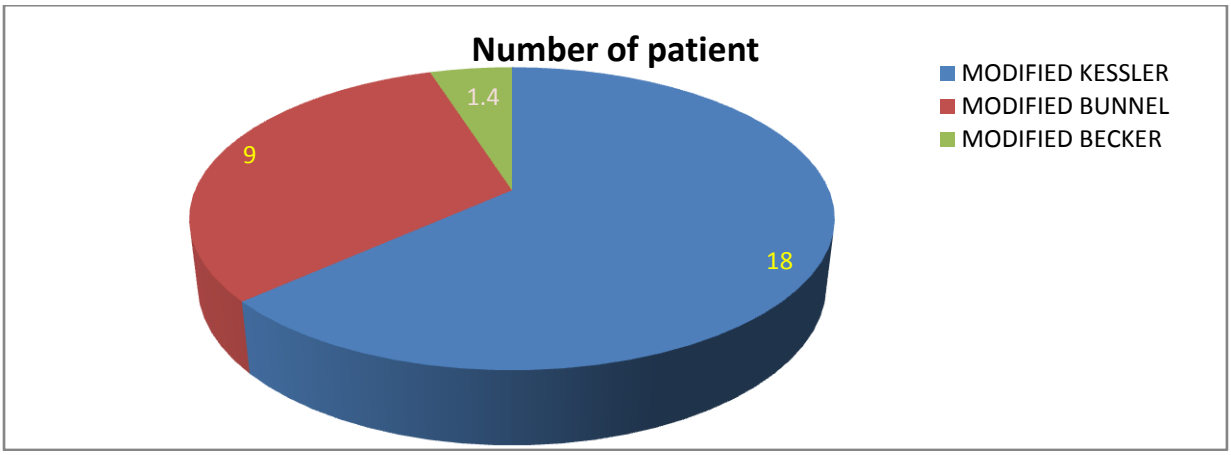
Number of tendons injured

Zone of injury	Number of tendons
I.	1
II.	2
III.	5
IV.	9
V.	13
VI.	16
VII.	16
VIII.	12
TOTAL	74

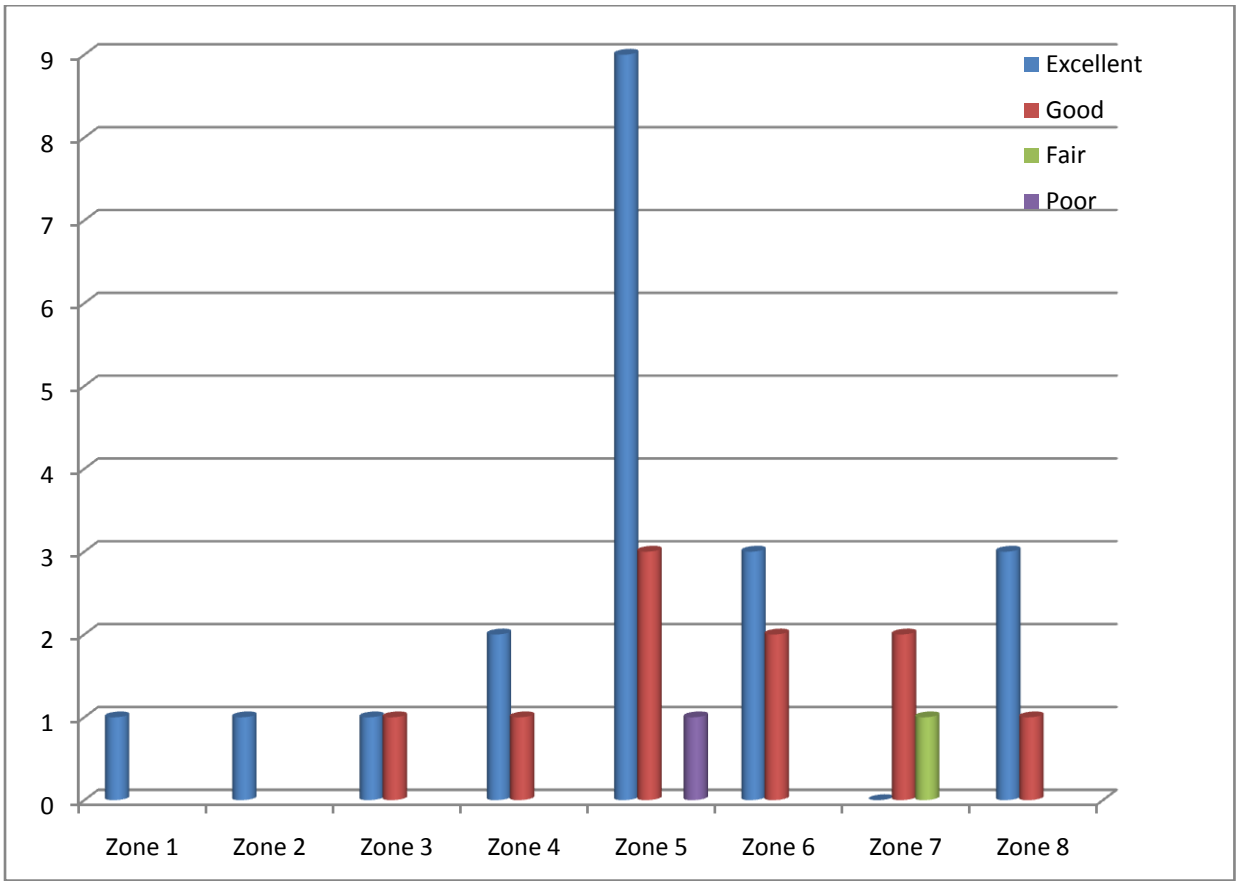


Repair technique

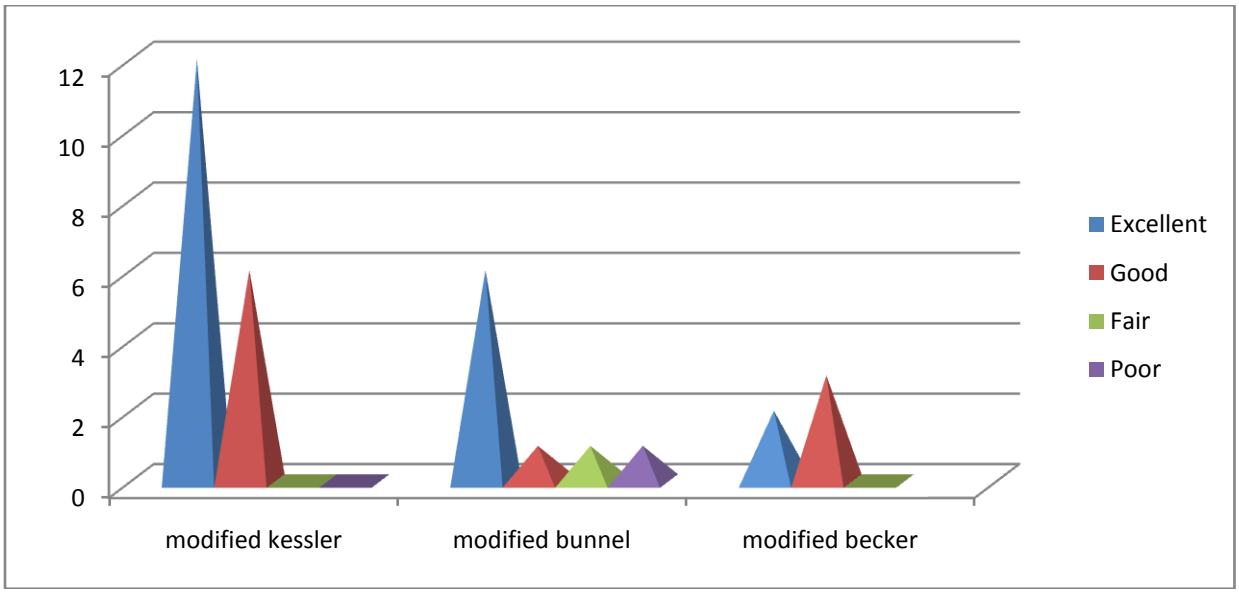
Technique	No. of patients	Number of tendons
Modified Kessler	18	35
Modified Bunnel	9	24
Modified Becker	5	15



	Results (number of patients)				
Zones	**Excellent**	**Good**	**Fair**	**Poor**	
I.	1				
II.		1	1		
III.	2	2			
IV.	1	3	1		
V.	6	1		1	
VI.	4	1			
VII.	2	1			
VIII.	4				



Technique	Total no. of patients	Results			
		Excellent	Good	Fair	Poor
Modified Kessler	18	12 [66.6%]	6 [33.3%]	0	0
Modified Bunnel	09	6 [66.6%]	1 [11.1%]	1 [11.1%]	1 [11.1%]
Modified Becker	05	2 [40%]	3 [60%]		



Core suture technique-- We chose three techniques modified - Kessler, modified Bunnel and modified Becker technique for the repair and all three techniques having only two core sutures.
Core suture technique does not affect the result of this study.

Descriptive: Technique

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Excellent	20	1.50	.688	.154	1.18	1.82	1	3
Good	10	1.70	.949	.300	1.02	2.38	1	3
Fair	1	2.00	.	.	.	.	2	2
Poor	1	2.00	.	.	.	.	2	2
Total	32	1.59	.756	.134	1.32	1.87	1	3

Whichever method is used for the repair, the results do not depend on the method of repair (f-0.338)

IV. Discussion

Correct diagnosis and treatment of ETI of the hand and wrist are essential, because these lesions are commonly observed in young working population. A careful clinical history, assessment of injury and knowledge of the mechanism of injury, surgical technique, and the physiopathology of tendon healing is important for making diagnosis, surgery, and good clinical outcome.

On the dorsum of the hand and fingers there is a relative lack of soft tissue, therefore adhesions of the tendon to skin are common, the bone and joints being very close to the dorsal surface are injured concurrently with extensor tendons. These tendons have no vincula; their blood supply is segmental, arising from the surrounding soft tissue and paratenon. Extensive dissection devitalizes these tendons and promotes scarring.

Evolution of surgical techniques and rehabilitative treatment protocol led to gradual improvement in clinical results of ETI treatment and surgical repair. Injury classification into anatomical zones and the evaluation of the characteristics of the lesions are considered key points to select the appropriate treatment for ETI.

Clinical results of extensor tendon function may be assessed according to Miller's criteria based on total extension lag and total flexion loss. Following those criteria is a common opinion that ETIs in zones I to IV have worse results than those in zones V to VIII.[8,9] Proximal extensor tendon repair is facilitated by the large thickness of tendons that may accommodate a core suture reinforced by dorsal cross stitches. Conversely, the reduced thickness of extensor tendon in distal zones can make the suture difficult. Moreover, at this level minimal variation in tendon length and tension may cause significant extension and flexion lag after tendon repair.

Tendon injuries were more often found in persons at their best working age. In the present prospective study, 75% of the patients were between age group of 20-60yrs. Maximum number of patients were in 3rd and 4thdecade of life. Slater RR et al[10] found similar incidence where most of the patients were between 20 to 40 years.

In our study 94 % patients sustained injuries to the tendons by sharp objects, followed by blunt trauma seen in 6 % patients. In the present series we used the classification of Kleinert and Verdan. The most common site of injuries was in zone V total consist of 8 patients (25%). Hung LK et al [17] concluded that injuries distal to knuckles (zones II, III, IV) showed worst results with an average total active motion of only 188 degrees (range, 95 to 270 degrees). Our study also reveals that all the patients with zone VIII and IX injuries achieved excellent results while lesions involving digits had variable results.Sofar,we do not have long-term clinical results, but good and excellent results have been observed in preliminary reports for digital zones V to VIII in case of ETI repair with these techniques.

We chose three techniques modified Kessler, modified Bunnel and modified Becker technique for the repair and all three techniques having only two core sutures and study shows core suture technique does not affects the result.

V. Conclusion

Despite recent research findings, a lack of evidence-based knowledge is still observed in the treatment of ETI. Further clinical and biomechanical investigations may give additional information about the timing and the rationale of surgical approach, the operative technique, and the postoperative management.

1. Modified Kessler technique was technically easy to perform and have short learning curve.
2. The higher percentage of excellent and good cases in might be attributable to strong and meticulous repair in which more aggressive physiotherapy was tolerated by the patients.
3. The tendons should be repaired preferably primarily.
4. Post-operative early controlled mobilization provides better rehabilitation in extensor tendon injuries.
5. In motivated patients, active motion protocols are recommended.
6. Regular follow up of all repaired extensor tendon is advisable in third week, and then next week, and then every 2 weeks for at least three months.

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