Zagazig University Medical Journal
www.zumj.journals.ekb.eg

https://doi.org/10.21608/zumj.2024.280385.3298 Volume 30, Issue 8.1, NOV. 2024, Supplement Issue

Manuscript ID ZUMJ-2403-3298
DOI 10.21608/zumj.2024.280385.3298

Original Article

# Modified Brunelli Pull-out Technique versus Modified Kessler Technique in Flexor Tendon Repair for Zone II

**Alshymaa Saeed Hemada Abd Elaal*[1], Mohammed Salah Awad[1], Mohammed Ali Nasr[1], Sherif Tawfik Sarhan [2]**

[1]Plastic and Reconstructive Surgery Department, Faculty of Medicine, Zagazig University
[2]Consultant Orthopedic Surgery, Ministry of health, Egypt. Business, Economics and Communication, AUC.

**Corresponding author:**
Alshymaa Saeed Hemada Abd Elaal

**Email:**
alshymaasaeed@gmail.com

Submit Date 30-03-2024
Revise Date 03-04-2024
Accept Date 06-04-2024

## ABSTRACT

**Background:** The reconstruction of tendon continuity, particularly in zone II, of the fingers is one of the most challenging aspects of hand surgery. The present work aimed to compare the results of two techniques: modified Brunelli technique and Modified Kessler sutures techniques regarding operative time, suture strength, gap formation, and efficiency of two strand suture repair. **Methods:** This prospective randomized clinical trial as was carried out on 42 patients with acute flexor tendon injuries, smooth tendon suture was used for restoring a gliding surface, patients were allocated into two equal groups (21patients in each group): Group I were managed by modified Brunelli pull out technique and Group II were managed by modified Kessler suture technique. The patients were followed for 6 months to assess grip strength, active range of motion, active mobilization against resistance and rupture rates.**Results:** A high statistically significant (p-value < 0.001) increased operative time was revealed in group I (74.7 ± 13.5 min) when compared with group II (45.9 ± 15.2 min). A Statistically significant (p-value = 0.04) increased percentage of extension deficit of IP joint was found in group II (9 patients, 42.9%) when compared with group I (3 patients, 14.3%). Statistically significant differences were revealed between both studied groups as regard pinch strength, and satisfaction (p-value = 0.04).**Conclusion:** Active mobilization against resistance can begin at the very first stage by shifting strain away from the healing site and onto the pulp of the finger. In addition to preventing joint stiffness and extension deficits in the interphalangeal joints, this helps with tendon modelling and leads to minimum adhesion formation.

**Keywords:** Modified Brunelli Pull-out, Modified Kessler Technique, Flexor Tendon Repair.

## INTRODUCTION

Maintaining the integrity of the flexor tendons in the fingers, particularly in zone II, is a persistently difficult issue in hand surgery. Outcome is affected by factors such as the patient's cooperation, the complexity of the local anatomy, the difficulty of the procedure and the need for competent and careful rehabilitation following the operation. Lesions affecting the flexor tendon account for less than one percent of all hand injuries, but they can have a significant influence on hand function, which is problematic for the patient and society at large [1].

In order to achieve a functional range of motion, the optimal repair for these lesions would give enough strength and allow for early mobilization. One of the most common methods for zone II is the two-strand modified Kessler suture in conjunction with a circumferential running suture [2].

Several multi-strand methods were detailed in an effort to make this suture stronger. Brunelli and Monini proposed a method that, in theory, relocates the area of maximal stress from the tendon site to the location of tendon insertion in order to circumvent the potential tendon bulkiness that may result from employing such procedures. To begin the suture, the two-needle method developed by Brunelli and Monini involves inserting the needles into the tendon's proximal stump and the finger pulp's distal stump [3].

To prevent squeezing the surrounding tissues, the modified technique involves starting the suture at the distal end and working our way proximally. We then exit the tendon and re-enter halfway between the insertion and stump of the tendon to complete the procedure [4]. In place of the standard Kessler grasping suture, a modified Kessler suture can be utilized. One benefit of this type of suture is that it leaves the knot on the tendon's sliced surface. The difficulty in sliding the tendon on some suture materials to obtain a sufficient approximation of the tendon ends is one potential problem. The following adjustments may help reduce the issue of exposed suture material [4]. The present work aimed to evaluate the two methods, the modified Brunelli technique and the modified Kessler suture techniques, in terms of the following: operating time, gap formation, suture strength, rupture rate, efficiency of two strand suture repair and early active mobilization against resistance in obtaining a good range of flexion rate.

## METHODS

In a prospective randomized clinical study, we performed this study on 42 patients with acute flexor tendon injuries admitted from the emergency department of Zagazig University Hospitals and we managed at the Department of Plastic and Reconstructive Surgery, Faculty of Medicine, Zagazig University, within the period from June 2023 to December 2023. All subjects provided written informed consent, and the study was approved by the research ethical committee of Zagazig University's Faculty of Medicine. Research involving human subjects was conducted in accordance with the principles outlined in the Declaration of Helsinki, which is part of the World Medical Association's Code of Ethics. Institutional Review Board (IRB#10887/13-6-2023) approval was required before this study could begin.

Cases with the following criteria were included: Adult patients aged from 13 -50 years old with no gender predilection who agreed to participate in the study and the time interval between trauma and repair to be less than 5 days. Cases with the following characteristics were excluded: Patients who aged less than 13 years or more than 50 years, patients with associated fractures, patients with trauma more than 5 days before presentation and those who refused to be enrolled in the study.

All participants were subjected to Complete history taking including personal, complaint, present, past and family history, hand dominance and special habits of medical importance. History of the injury itself: mechanism, timing and scene of injury were collected. Patient Communication and explanation of the procedure and postoperative management. Full clinical examination, either general for all systems and Evaluation of the injured hand regarding: Evaluation of skin wound: site, size, type, degree of contamination, presence of skin loss. Tendon assessment: Injury detected by loss of function, Tenodesis, Type of tendon injury, evaluation of the hand skeleton, evaluation of the joints in the affected region and their range of movement, with assessment of associated injuries: Vascular injuries or nerve injuries. Laboratory work up was done for preoperative assessment. Radiographic examination: Hand radiographic series: Anteroposterior, lateral and oblique views of the digits were obtained. Standardized color digital photography and video recording of the site of injury was done.Intravenous antibiotics were initiated immediately; first generation cephalosporin (cefazoline 1 gm. I.V). Tetanus prophylaxis was given to all the cases if not initially immunized.

Patients recruited for this study were assigned randomly to one of the two groups based on simple random selection using the sealed envelope method.

The choice of general or regional anesthetic for each procedure was determined by the surgeon and the patient's level of cooperation. Supine on a side table, the patient had one arm outstretched. A pneumatic arm tourniquet was placed 50 mm Hg above the systolic blood pressure after the wound was extensively irrigated. Next, the hands and forearms were draped for disinfection, and scrubbing was performed. Levels of incisions in the tendons in respect to their superficial tissues served to identify the location of the fingers of the hand. During surgery, the assistant would often hold the hand to allow for adjustments. Oblique incisions at both ends stretched into Bruner-like zigzag incisions and the wound itself served as the surgical approach. The main considerations for the selection of the incision site were to safeguard the underlying neurovascular bundles from damage and to avoid scarring by not crossing flexion creases at right angles.

To access the palm, incisions were made either parallel to the flexion creases or at an angle to them. The point of a narrow skin flap might not make it through the procedure, so it's best to keep that in mind.When it comes to flexor tendon injuries in the palm, it seems that the lumbricals, which originate from the FDP at this level, were mostly undamaged, making it easier to expose and heal the tendon's cut ends. It was crucial to know where the tear was along the tendon sheath route in order to plan the incision. The distal tendon end (or ends, in the case of an FDS and FDP injury) will likely require more distal exposure for retrieval and repair compared to an extended digit if the digit was retained in flexion when the injury occurred. It was expected that the proximal ends would be collected when the distal cut ends were exposed. Many times, the cut ends might be "milked" into the wound by flexing the wrist and fingers and kneading the volar forearm musculature from proximal to distal. Subsequently, the sheath was accessed by inserting a curved tendon passer and directing it proximally to secure the proximal cut ends. Nerves, blood arteries and the tendon's proximal cut end were all carefully avoided.

Carry on with the tendon exposure in the palm if this did not succeed in extracting the proximal cut end after several delicate efforts. The tendon was exposed through a transverse incision made at the level of the distal palmar crease, just proximal to the A1 pulley. Sometimes, with the help of non-toothed forceps, the severed tendon can be carefully advanced distally into the digit's incision. Failure to achieve this resulted in the insertion of a small pediatric feeding tube (typically 5 French) into the sheath, which was then pushed distally towards the distal wound. In most cases, the tendons were brought into the distal wound by gently drawing the feeding tube distally after tying them to the sliced tendons with a suture. In order to keep the repaired tendon ends at their intended location, a 25-gauge needle was transversely inserted into both the proximal and distal ends of the healed tendon.It was critical to restore a gliding surface with low friction and to aid in tendon rehabilitation by using a smooth tendon suture.

Then according to patients previous allocation into two groups:

Group A: 21 cases have been operated using modified Brunelli pull out technique. Group B: 21 cases have been operated by modified Kessler suture technique.

**Modified Brunelli pull out technique**

As a first adjustment to the first method, the tenorrhaphy was performed with a 3-0 monofilament nonabsorbable single needle suture. Second, instead of starting the suture at the stump of the proximal tendons, the distal approach of inserting the suture through the pulp of the finger was used in the Brunelli and Monini procedure. Finishing the slipknot was very much like the first method. The suture was tied over the pulp of the finger after it has passed through the distal stump. Lastly, a 5-0 absorbable circumferential running suture was used to symbolize the third change (Figure 1).

**Modified Kessler suture technique.**

One third of the tendon's diameter was penetrated by a single 3/0 nonabsorbable polypropylene suture, which was inserted into the tendon's cut end core. The lateral tendon margin should be threaded with the suture. Continue wrapping the 4/0 nonabsorbable polypropylene suture around the tendon and re-enter on the dorsal radial side of the tendon perpendicularly, 1-2 mm closer to the tendon end. Finish by completing the procedure with the suture (Figure 2).

The tendon edges were opposed before tying the knot within the repair site, Tension was placed on the sutures by opposing the two ends. All suture material used were of the same caliber 3/0 polypropylene (Ethicon), round curved needle but for the little finger was 4/0 instead. All core sutures were followed by circumferential continuous unlocked epi-tendineous sutures using 4/0 polypropylene (Ethicon) in group (B) and a 5/0 absorbable circumferential running suture in group (A).

A2 & A4 pulleys were preserved except if more exposure was needed and up to 50% venting was performed to ensure smooth gliding of the sutured tendons. In both groups: Closure of the wound: with simple interrupted sutures using 4/0 polypropylene (Ethicon). Splinting: immobilization in a dorsal blocking splint with a slight flexion of the wrist (20°–30°), 50° flexion of the MCPJ and extension of the IP joints.

**Digital neurovascular bundle repair**

Tension-free epineural suture repair using 8/0 polypropylene (Ethicon) remains the preferred treatment option for nerve injury. Arteries were repaired whenever they were injured by microsurgical techniques. Clinical data were collected regarding symptoms, signs, laboratory investigations and radiological findings. Operative data: operative time, associated nerve or vascular repair, gap formation and skin loss. In cases where FDS tendon was injured, we did either repair using modified Kessler techniques or sacrificed its repair.

**Post-operative follow-up:** Early regulated active motion was prescribed to the patients on the very first day in group of modified Brunelli Technique, but in modified Kessler group, acutely passive flexion was prescribed. After the wound had healed, the sutures were removed; the median time for this process was 12 days. The patients had scheduled visits to outpatient clinic 3 times per week for the whole the first two weeks of the rehabilitation course. Then, every week for the first month then every month for 6 months. The following measures were assessed:

**Grip strength.**

In our study, we assessed the grip strength by having patients squeeze the sphygmomanometer cuff while their arms were adducted, elbows were flexed, forearms were supinated, and their wrists were bent at a 30° angle. The next step was to compare the damaged hand's pressure reading to the normal reading after compressing the cuff.

**Active range of motion**:

in accordance with Strickland's criteria, which represent the percentage difference between the injured finger's active range of motion and that of the healthy finger on the opposite side. Hand goniometry with a typical finger goniometer was used to record the measurements. The results were evaluated based on the American Society for Surgery of the Hand-defined Total Active Movement (TAM) score. The thumb's typical TAM was 130°, whereas the digits' typical TAM was 260°. Following surgery, the MCPJ, PIPJ and DIPJ joints had their range of motion (ROM) measured with a Goniometer [4].

**Statistical Analysis:** Statistical Program for the Social Sciences (SPSS) version 24 was used for data analysis. Frequency and percentage were used to express the qualitative data. Mean ± SD was used to express quantitative data. The middle value of a discrete set of integers, calculated by dividing the sum of values by the number of values, was called the mean or average. When comparing two groups, the independent sample T test (T) was used, assuming the data was normally distributed. When comparing non-parametric data, the chi-square test was employed.

## RESULTS

**Table 1 and 2:** show that age, sex, marital status, occupation, residency and smoking history, dominant hand, affected fingers, associated FDS injury and time of injury did not differ significantly between the both groups .

**Table 3:** show that the Operative time increased significantly in group I (74.7 ± 13.5 min) when compared with group II (45.9 ± 15.2 min). Also, statistically significant (p-value = 0.04) increased percentage of extension deficit of IP joint of group II was revealed (9 patients, 42.9%) when compared with group I (3 patients, 14.3%).

**Table 4:** show that there was a statistically significant difference (p-value = 0.04) between studied groups (group I & group II) as regard pinch strength. Pinch strength was bad in 3 patients (14.3%) and good in 18 patients (85.7%) of group I. Pinch strength was bad in 9 patients (42.9%) and good in 12 patients (57.1%) of group I. Also, statistically significant difference (p-value = 0.04) was found between studied groups (group I & group II) as regard satisfaction. In group I, there were 3 not satisfied patients (14.3%) and 18 satisfied patients (85.7%). In group II, there were 9 not satisfied patients (42.9%) and 12 satisfied patients (57.1%).

**Table (1):** Demographic data distribution between studied groups.

| | | Group I (N = 21) | | Group II (N = 21) | | Stat. test | P-value |
|---|---|---|---|---|---|---|---|
| Age (years) | Mean | 29.5 | | 28.6 | | T = 0.36 | 0.718 NS |
| | ±SD | 8.07 | | 8.02 | | | |
| Sex | Male | 15 | 71.4% | 16 | 76.2% | $X^2$ = 0.12 | 0.726 NS |
| | Female | 6 | 28.6% | 5 | 23.8% | | |

| | | Group I (N = 21) | Group II (N = 21) | Stat. test | P-value | Group I (N = 21) | Group II (N = 21) |
|---|---|---|---|---|---|---|---|
| Marital status | Single | 10 | 47.6% | 10 | 47.6% | $X^2$ = 1.05 | 0.789 NS |
| | Married | 9 | 42.9% | 10 | 47.6% | | |
| | Widow | 1 | 4.8% | 1 | 4.8% | | |
| | Divorced | 1 | 4.8% | 0 | 0% | | |
| Occupation | Student | 4 | 19% | 7 | 33.3% | $X^2$ = 3.35 | 0.5 NS |
| | Teacher | 1 | 4.8% | 3 | 14.3% | | |
| | Manual worker | 9 | 42.9% | 7 | 33.3% | | |
| | Farmer | 2 | 9.5% | 2 | 9.5% | | |
| | Housewife | 5 | 23.8% | 2 | 9.5% | | |
| Residency | Rural | 6 | 28.6% | 8 | 38.1% | $X^2$ = 0.42 | 0.513 NS |
| | Urban | 15 | 71.4% | 13 | 61.9% | | |
| Smoking | No | 12 | 57.1% | 12 | 57.1% | $X^2$ = 0.0 | 1.0 NS |
| | Yes | 9 | 42.9% | 9 | 42.9% | | |

**Table (2):** Preoperative patients' clinical data between studied groups.

| | | Group I (N = 21) | | Group II (N = 21) | | Stat. test | P-value |
|---|---|---|---|---|---|---|---|
| **Dominant hand** | **Right** | 17 | 81% | 17 | 81% | $X^2$ = 0.0 | 1.0 NS |
| | **Left** | 4 | 19% | 4 | 19% | | |
| **Affected fingers** | **Index finger** | 6 | 28.6% | 11 | 52.4% | $X^2$ = 2.4 | 0.116 NS |
| | **Middle finger** | 10 | 47.6% | 11 | 52.4% | $X^2$ = 0.09 | 0.758 NS |
| | **Ring finger** | 1 | 4.8% | 4 | 19% | $X^2$ = 2.04 | 0153 NS |
| | **Little finger** | 4 | 19% | 2 | 9.5% | $X^2$ = 0.77 | 0.378 NS |
| **associated FDS injury** | **No** | 13 | 61.9% | 13 | 61.9% | $X^2$ = 0.0 | 1.0 NS |
| | **Yes** | 8 | 38.1% | 8 | 38.1% | | |
| **Associated Nerve or Vascular repair** | | 3 | 14.3% | 5 | 23.8% | $X^2$= 0.61 | 0.432 NS |
| **Time of injury (days)** | **Mean** | 1.61 | | 1.66 | | T = 0.22 | 0.827 NS |
| | **±SD** | 0.66 | | 0.73 | | | |

**Table (3):** Operative time distribution and complications between studied groups.

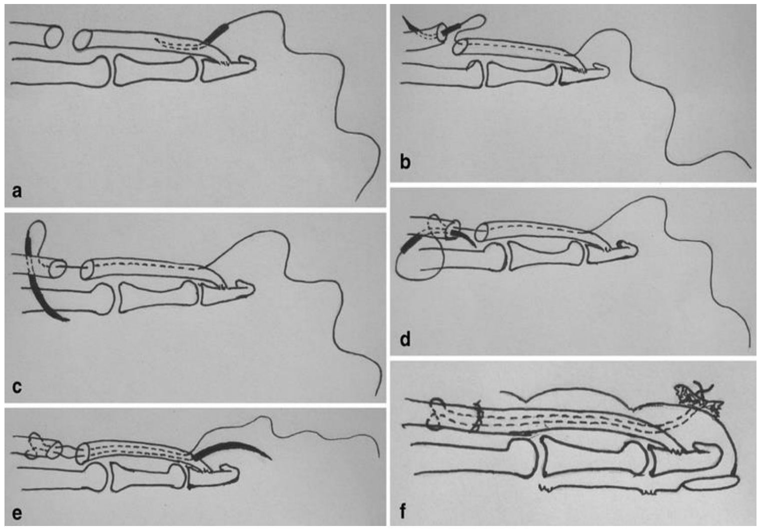
| | | Group I (N = 21) | | Group II (N = 21) | | Stat. test | P-value |
|---|---|---|---|---|---|---|---|
| Operative time (min) | Mean | 74.7 | | 45.9 | | T = 6.4 | < 0.001 HS |
| | ±SD | 13.5 | | 15.2 | | | |
| | | Group I (N = 21) | | Group II (N = 21) | | $X^2$ | P-value |
| | Gap formation | 0 | 0% | 0 | 0% | --- | --- |
| | Skin loss | 0 | 0% | 0 | 0% | --- | --- |
| | Infection | 2 | 9.5% | 6 | 28.6 % | 2.47 | 0.116 NS |
| | Rupture tendon | 0 | 0% | 0 | 0% | --- | --- |
| | Extension deficit of IP joint | 3 | 14.3% | 9 | 42.9 % | 4.2 | 0.04 S |

T: Independent sample T test. HS: p-value < 0.001 is considered highly significant.

**Table (4):** Late outcomes distribution between studied groups.

| | | Group I (N = 21) | | Group II (N = 21) | | Stat. test | P-value |
|---|---|---|---|---|---|---|---|
| **Pinch strength** | **Bad** | 3 | 14.3% | 9 | 42.9% | $X^2$ = 4.2 | 0.04 S |
| | **Good** | 18 | 85.7% | 12 | 57.1% | | |
| **satisfaction** | **Not satisfied** | 3 | 14.3% | 9 | 42.9% | $X^2$ = 4.2 | 0.04 S |
| | **Satisfied** | 18 | 85.7% | 12 | 57.1% | | |

$X^2$: Chi-square test. S: p-value < 0.05 is considered significant.



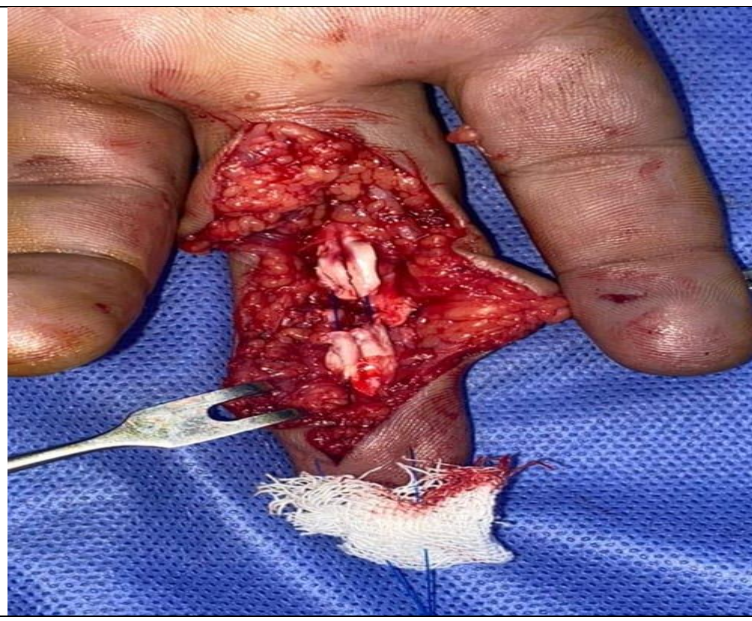
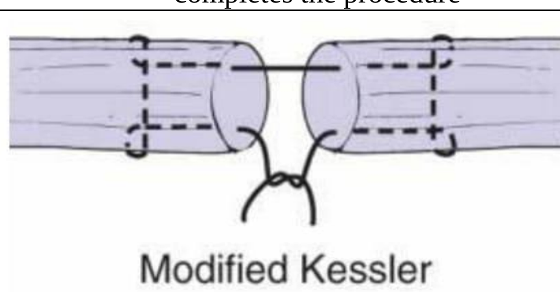



Figure 1: showing modified Brunelli pull-out technique. a The suture is started from the finger pulp. b, c, d The completion of the slipknot. e The suture passes through the distal stump. f The suture passes through the distal stump. f The suture is tied over on the finger pulp, and a 5–0 absorbable circumferential running suture completes the procedure



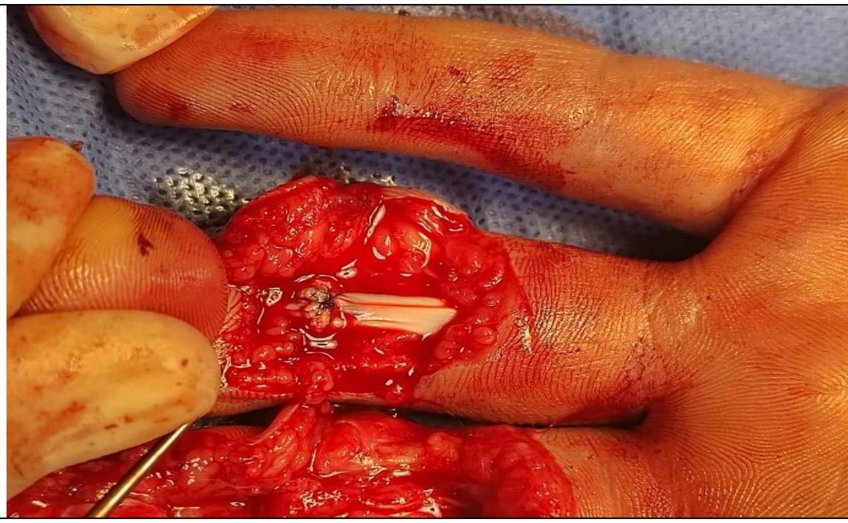


Figure 2: Showing Modified Kessler Suturing technique

## DISCUSSION

Optimal tendon reconstruction aims to provide enough strength, minimize gapping at the repair site, promote healing and allow for efficient tendon gliding and excursion. Despite evidence that strong suture repair can facilitate early active motion, surgeons and patients alike remain divided on the optimal intraoperative and postoperative management of these injuries [5].

This study compared using of two different techniques; The modified Brunelli pullout technique group (A) and modified Kessler suture and group (B) for primary flexor tendon repair. The study was conducted on 42 patients (21 patients in each group) who sustained acute flexor tendon injury recruited from the emergency department of Zagazig University Hospitals. We found that there was no statistically significant difference between studied groups (group I & group II) as regard age; (29.5 ± 8.07 years) in group A versus (28.6 ± 8.02 years) in group B.

Regarding sex, in group I, there were 15 males (71.4%) and 6 females (28.6%) while in group II, there were 16 males (76.2%) and 5 females (23.8%) with no statistically significant difference between studied groups. Marital status, occupation, residency and smoking were also not statistically significant different between studied groups. All patients were treated by primary repair within the first 5 days of injury, most of the cases were operated on in first two days 1.61 ± 0.66 days in group A versus 1.66 ± 0.73 days in group B with no statistically significant difference (p-value = 0.827) between studied groups.

The optimum suture material should be non-reactive, small diameter, robust, easy to handle and able to retain a decent knot. In all cases, we employed polypropylene (Ethicon) in either core (3/0) or (4/0). Therefore, Polypropylene meets all of our requirements.

Wade et al. [6] choose polypropylene because it is frequently used by surgeons, has comparable strength to nylon, stretches less and is more slippery. Its material can transmit loads that are much higher than its breaking force by the number of individual or continuous strands that cross the suture line.

In the present study there was high statistically significant (p-value < 0.001) increased operative time in group A (74.7 ± 13.5 min) when compared with group B (45.9 ± 15.2 min). This could be due to the difficulty of the technique regarding the entry and exit of the needle, holding the suture and maintain the alignment of the two ends within the pulley system of the finger in comparison to the well oriented, experienced and widely used modified Kessler suture technique

No statistically significant difference between studied groups as regard associated nerve or vascular repair. Nerve or vascular repair was associated with 3 patients (14.3%) in group A versus 5 patients (23.8%) in group B. Complications as infection (9.5% versus 28.6%), gap formation¸ skin loss and tendon rupture were evaluated during the post operative and follow up period and we found that there was no statistically significant difference between studied groups. Statistically significant (p-value = 0.04) increased percentage of extension deficit of IP joint of group B (9 patients, 42.9%) when compared with group A (3 patients, 14.3%).

Georgescu et al. [3] who used the modified Brunelli pullout technique, reported that the rate of complications is modest when the patient is cooperative and the hand therapist is skilled. On the other hand, 31 percent of patients had an extension deficit ranging from 10 to 20, and 11.3% had a deficiency ranging from 5 to 10.

The goal of post-operative care for flexor tendon injuries in the hand is to minimize damage to the repaired area while simultaneously preventing adhesions from forming by encouraging early motion.

In an attempt to alter the typical biological progression of tissue healing and lessen the development of limiting adhesions surrounding the tendon repair, a plethora of methods and variations on these approaches have been developed [7].Because tendon adhesions can start anywhere on the tendon surface that has been damaged by crushing equipment (such as hemostasis devices, tendon retrievers, or forceps), surgeons sought to limit additional damage to anatomical structures. Injured structures (such as annular ligaments, bone, or periosteum) in the tendon's injury field would take part in the healing process by adhering to the tendon [8].

In 1989, Small et al. [9] utilized a conventional Kessler repair while documenting controlled active mobilization (active flexion/extension). Four percent to forty-three percent of patients experienced such active mobilization ruptures following conventional two-strand repair [10].

According to Gibson et al. [5], members of the American Society for Surgery of the Hand (ASSH) favored sutures with two strand repairs, and they proposed a modified Kessler suture with two strand repair to handle the load caused by passive movement. The repair strength rises as the number of core sutures increases. The increased work of flexion caused by the bulky repair is an adverse effect of multi-strand repairs. Pulley venting is typically necessary for multi-strand repairs due to this reason [11].After first repair, the rupture rate typically falls within the range of 4-10% of fingers [12].If we limit our discussion to zone II primary flexor tendon repairs using the Kessler and circumferential sutures, the majority of data indicate a rupture rate ranging from 3-9% [13].The zero rupture rate reported by O'Connell et al. [14] is based on a single series including 95 children.We didn't report any case of tendon rupture in either of the studied groups. This is consistent with Georgescu et al. [3] who reported no case with tendon rupture.

In comparing these results with Silfverskiöld and May. [15] who used cross-lock cruciate repair (4-strand repair) in 46 patients (55 digits), two ruptures were reported but extension lag was not taken into consideration.

The cross-lock cruciate repair was done using a single suture which minimizes the bulk of the repair and makes it technically easy, but its drawbacks include exposed suture on the tendon surface, excessive tensioning of the repair at the time of final knot tying cannot be easily accomplished and it was depending on only one knot which if no sufficient tensioning, gapping would occur [16].

We didn't report any case with gap formation in any group Başar and Tetik. [17] reported that in comparison to a single application of the modified Kessler suture technique, the modified Brunelli suture approach was considerably more effective in creating noticeable gaps and ripping the suture in the repair area (p < 0:0001).

Regarding the post-operative outcome as pinch strength, there was statistically significant difference (p-value = 0.04) between studied groups. Pinch strength was bad in 3 patients (14.3%) and good in 18 patients (85.7%) of group A. while in group B it was bad in 9 patients (42.9%) and good in 12 patients (57.1%) of group B.

Also, statistically significant difference (p-value = 0.04) was revealed between studied groups as in group A, there were 3 not satisfied patients (14.3%) and 18 satisfied patients (85.7%). In group B, there were 9 not satisfied patients (42.9%) and 12 satisfied patients (57.1%).

This study differs from Sandow and McMahon. [18] regarding the technique. They used a 4-strand single cross grasp technique for repair of acute zone 1 and 2 FDP tendon lacerations in 53 patients (73 digits) with an active Mobilization regimen. Good and excellent results were obtained in 71% of repaired cases.

Using a modified Kessler 4-strand core suture and epitendineous suture repair, they operated on 128 fingers of 89 patients with flexor tendon laceration in zone 2, which is similar to the method employed by Güntürk et al. [10]. Although 90% of cases had satisfactory or outstanding results, 10% experienced PIPJ contracture greater than 20°. In fingers with lacerated FDP and FDS tendons, they indicated that there was no significant correlation between FDP repair alone and FDP and FDS repair together.

## CONCLUSION

One of the most difficult issues in hand surgery involves reconstructing the continuity of flexor tendons that have been disrupted, particularly in zone II. In order to achieve a functional range of motion, the ideal repair would offer enough strength and the chance for early mobilization. By transferring the stress to the pulp of the finger instead of the healing site, active mobilization against resistance can start at the very first stage. This helps with accurate tendon modelling, reduces the likelihood of adhesion formation, and keeps the interphalangeal joints from becoming stiff or having an extension deficit.

**No potential conflict of interest was reported by the authors.**

## REFFERENCES


1. Pebam MS, Singh AI, Das S, Singh LO, Sinam N and Singh SN. A prospective comparative study of pull-out suture technique versus modified Kessler technique in flexor tendon repair for Zone I and distal Zone II injuries. J. Med. Soc.,2021, 35(2), 72.
2. Vögelin E. IFSSH Scientific committee on flexor tendon repair. Ezine IFSSH,2015, 5(4), 21-34
3. Georgescu AV, Matei IR, Capota IM, Ardelean F, Olariu OD. Modified Brunelli pull-out technique in flexor tendon repair for zone II: a study on 58 cases. Hand (N Y). 2011;6(3):276-81.
4. Rigó IZ, Haugstvedt JR, Ludvigsen P, Røkkum M. Comparison of modified Kessler and Yotsumoto-Dona suture: a biomechanical study on porcine tendons. J Plast Surg Hand Surg. 2012;46(5):313-7.
5. Gibson PD, Sobol GL, Ahmed IH. Zone II Flexor Tendon Repairs in the United States: Trends in Current Management. J Hand Surg Am. 2017;42(2).99-108.
6. Wade PJ, Wetherell RG, Amis AA. Flexor tendon repair: significant gain in strength from the Halsted peripheral suture technique. J Hand Surg Br. 1989;14(2):232-5.
7. Zhao C, Amadio PC, Momose T, Couvreur P, Zobitz ME, An KN. The effect of suture technique on adhesion formation after flexor tendon repair for partial lacerations in a canine model. J Trauma. 2001;51(5):917-21.
8. Titan AL, Foster DS, Chang J, Longaker MT. Flexor Tendon: Development, Healing, Adhesion Formation, and Contributing Growth Factors. Plast Reconstr Surg. 2019;144(4):639-47.
9. Small JO, Brennen MD, Colville J. Early active mobilisation following flexor tendon repair in zone 2. J Hand Surg Br. 1989;14(4):383-91
10. Rigó IZ. Flexor tendon repair in fingers: Suture technique, postoperative rehabilitation and predictors of outcome.2017.
11. Güntürk ÖB, Kayalar M, Kaplan İ, Uludağ A, Özaksar K, Keleşoğlu B. Results of 4-strand modified Kessler core suture and epitendinous interlocking suture followed by modified Kleinert protocol for flexor tendon repairs in Zone 2. Acta Orthop Traumatol Turc. 2018;52(5):382-6.
12. Tang JB. Clinical outcomes associated with flexor tendon repair. Hand Clin. 2005;21(2):199-210.
13. Cullen KW, Tolhurst P, Lang D, Page RE. Flexor tendon repair in zone 2 followed by controlled active mobilisation. J Hand Surg Br. 1989;14(4):392-5.
14. O'Connell SJ, Moore MM, Strickland JW, Frazier GT, Dell PC. Results of zone I and zone II flexor tendon repairs in children. J Hand Surg Am. 1994;19(1):48-52.
15. Silfverskiöld KL, May EJ. Flexor tendon repair in zone II with a new suture technique and an early mobilization program combining passive and active flexion. J Hand Surg Am. 1994;19(1):53-60.
16. Ishak A, Rajangam A, Khajuria A. Evidence base for the management of flexor tendon injuries. Ann Med Surg (Lond). 2020;55:212.
17. Başar H, Tetik C. Modified Brunelli pull-out suture technique in zone II flexor tendon rupture: a fresh human cadaver study. Hand Surg. 2014;19(3):349-55.
18. Sandow MJ, McMahon M. Active mobilisation following single cross grasp four-strand flexor tenorrhaphy (Adelaide repair). J Hand Surg Eur Vol. 2011;36(6):467-75.


## Citation

**Abd Elaal, A. S. H. A. E., Awad, M., Nasr, M., Sarhan, S. Modified Brunelli Pull-out Technique versus Modified Kessler Technique in Flexor Tendon Repair for Zone II. *Zagazig University Medical Journal*, 2024; (4282-4291): -. doi: 10.21608/zumj.2024.280385.3298**