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Comparison of surgical trends in zone 2 flexor tendon repair between Turkish and international surgeons

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ABSTRACT

Objectives: The aim of this study was to evaluate Turkish trends in zone 2 flexor repair with regards to surgical technique, suture materials, anesthesia and post-operative rehabilitation and compare this with international surgeons by modifying Gibson's survey.
Methods: A printed and online survey consisting of 19 questions modified from Gibson's survey was sent to 590 Turkish and international surgeons. The surgeon's years in practice, province of practice, residency type, number of zone 2 flexor tendon repairs done in a year, preferred surgical technique, suture material, complications and postoperative protocols were asked to the respondents.
Results: A total of 194 surgeons completed the survey (a 25% response rate). Of those who completed the survey, 91 were international (mostly from far eastern countries) and 103 were Turkish surgeons. Years in practice and educational background had influence on the decision-making. There were differences between the Turkish and international surgeons in the core and epitendinous suture thickness preference and flexor tendon sheath repair. There was a statistically significant relationship between the province of practice and the use of WALANT (Wide awake local anesthesia no tourniquet) ($p < 0.05$). While the majority of respondents who preferred postoperative early passive motion protocol were from Turkey (61.5%), the majority of respondents who preferred early active motion protocol were practicing abroad (73.9%).
Conclusion: Despite some variations the surgeons involved in this study follow to a large extent the current literature.
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Introduction

The area between the A1 pulley and the flexor digitorum superficialis (FDS) adhesion site on the palmar side of the hand is defined as Zone 2 by Verdan.[1] Bunnel[2] has described the complex anatomy of this region as “no man's land” in 1948 due to 2 tendons passing through a fibro-osseous digital sheath, and there have been inadequate results after surgery. This concept has changed in the last 30 years due to improvement in surgical techniques, suture materials, approaches to pulleys, and flexor sheath repair and postoperative rehabilitation protocols.[3–6]

The aim of the current treatment approach in zone 2 flexor tendon repair was to provide tendon healing with sufficient tensile strength and allow adequate tendon gliding and exudation without gap formation at the repair site.[3] However, there are differences in suture technique and post-operative rehabilitation protocols. Gibson[7] evaluated the suture materials, surgical techniques, and anesthesia and postoperative protocols preferences of hand surgeons who are practicing in the U.S. Tang[4] investigated the differences in flexor tendon repair techniques in elite hand surgery clinics across the world. To the best of our knowledge, there has been no study describing Turkish surgeons preferences in flexor tendon repair. In this study, we aimed to evaluate Turkish trends in flexor tendon surgery and compare this with international surgeons by modifying Gibson's survey.

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Methods

A printed and online survey consisting of 19 questions modified from Gibson's survey was sent to 590 Turkish and international surgeons who attended the Asian Pacific Federation of Societies for Reconstructive Microsurgery (APFSRM) 2018 Congress in Antalya. Since the second question in Gibson's survey was asking province of practice in the US, we have changed this question and asked participants whether they are practicing in Turkey. The online survey was also sent to Turkish surgeons who did not attend the APFSRM Congress. A brief explanation was included at the beginning of the survey. All results were submitted anonymously. The online version remained open for a month to obtain the maximum response rate.

The surgeon's years in practice, province of practice, residency type, number of zone 2 flexor tendon repairs done in a year was assessed in the survey. Respondents were asked questions regarding their surgical technique, suture material preference, complications, and postoperative protocols. We also asked whether they ever used Wide-awake local anesthesia, no tourniquet (WALANT) technique in their practice.

Data were analyzed using SPSS V22.0 (IL, USA) with 95% confidence intervals (CIs). Chi-square test was used to examine the relationship between qualitative variables. The study was approved by the Institutional Review Board.

Results

A total of 194 surgeons completed the survey (25% response rate). Of those who completed the survey, 91 were international (mostly from far eastern countries) and 103 were Turkish surgeons. The results regarding respondents' experience, background, and how they decided on tendon repair are given in Table 1.

There was a statistically significant relationship between years in practice and the factor that most influences the decision making ($p < 0.05$). The majority of surgeons (53.6%) who were mostly influenced by medical evidence had been practicing hand surgery for 10 years and more. Surgeons with less than 10 years of experience were mostly affected by familiarity, training, and department policy.

Respondents' surgical technique, core suture, and epitendinous suture preferences are listed in Table 2. There were differences between the Turkish and international surgeons in the core and epitendinous suture thickness preference, A2/A4 pulley venting, and flexor tendon sheath repair. While the majority of those who preferred 3-0 core suture were practicing in Turkey (64.6%), the majority of those who preferred 4-0 and 5-0 core suture were practicing abroad. While Turkish surgeons mostly preferred 5-0 epitendinous suture (69%), surgeons who were practicing in other countries preferred 5-0, 6-0 and 7-0 epitendinous sutures. The majority of Turkish and international surgeons partially released the A2/A4 pulley (98% vs. %83).

Surgeons who had been practicing for 10 years and more, mostly preferred to repair both slips of FDS and flexor digitorum profundus (FDP) (70.5%). Surgeons with less than 10 years of experience preferred only FDP repair (56.3%) or FDP and one slip FDS repair (64.3%). The majority (58.1%) of those who responded as "yes" to the repair of the flexor tendon sheath had less than 10 years of experience in hand surgery, while the majority (70.0%) of those who responded as "no" were working for 10 years or more.

While Turkish surgeons who had an orthopedic background mostly preferred PDS suture material (56.3%), surgeons who received plastic surgery education preferred Prolene (83.3%) and Ethibond (63.6%) suture material. Sixty-nine percent (69%) of Turkish plastic surgeons and 77% of Turkish orthopedic surgeons preferred 4-strand repair. While the majority of Turkish respondents preferred 4-strand modified Kessler (65%) and 4-strand

Table 1
Survey population demographic (%).

	International	Turkish
Years in practice		
0–5 years	30	39
5–10 years	10	26
10–15 years	21	12
>15 years	39	23
Type of residency		
Ortopedics	43	30
Plastic surgery	57	70
Zone II repairs in a year		
0–4 repairs	33	15
5–9 repairs	25	10
10–14 repairs	14	11
>15 repairs	28	64
What influence most your decision?		
Trends of the clinic being practiced	17	13
Medical evidence	27	28
Familiarity/training	28	35
Intraoperative findings	28	24

Table 2
Technique and material preference (%).

	International	Turkish
Type of Material		
Prolene	64	61
Ethibond	16	10
PDS	9	29
Fiberwire	5	0
Other	6	0
Core suture Size		
3-0	36	60
4-0,5-0	64	40
Technique		
Kessler	17	2
Modified Kessler (4-strand)	39	65
4-strand cruciate	20	30
Horizontal matrress	0	0
Stricland	3	0
Modified Savage	0	1
Tajima	21	0
Other	0	2
Strands (n)		
2 strand	32	25
4 strand	54	65
6–8 strand	14	10
Epitendinous repair		
Yes	87	93
No	13	7
Epitendinous suture size		
5-0	52	69
6-0,7-0	48	31
Preferred method		
Only FDP	18	25
FDP + FDS	65	55
FDP and 1 slip of FDS	17	20
Partial A2/A4 pulley release		
Yes	83	98
No	17	2
Flexor sheath repair		
Yes	31	20
No	69	80
Until how many weeks would you consider primary repair?		
3 weeks	37	46
4 weeks	30	34
5 weeks	33	20

cruciate technique (30%), international surgeons' preferences showed more homogenous distribution (Table 2).

There was a statistically significant relationship between the province of practice and the use of WALANT ($p < 0.05$). The majority of respondents who were performing flexor tendon repairs with WALANT technique were mostly practicing abroad (70.1%). Respondents who did not prefer WALANT technique were mostly practicing in Turkey (64.5%).

While the majority of respondents who preferred postoperative early passive motion protocol were from Turkey (61.5%), the majority of respondents who preferred early active motion protocol were practicing abroad (73.9%). Among the international respondents, surgeons who received plastic surgery training mostly preferred postoperative early active motion protocol (77.4%). Complications that require re-operation are listed in Table 3.

Discussion

Surveys do not contain scientific data about current evidence-based practices. However, they help us to understand the surgeon's habits and current practice patterns. This study provided a glimpse to flexor tendon repair intentions nationwide that has not been reported before.

Although there is no consensus among surgeons and clinics for zone 2 flexor tendon repair, good results can be obtained due to recent surgical techniques, suture materials, and rehabilitation protocols.[3]

Non-absorbable braided sutures or monofilament sutures such as Prolene, nylon, and absorbable sutures such as PDS are used in tendon repair surgery. Studies on durability have shown that Fiberwire suture is stronger than ethibond, Ticron, and monofilament sutures.[8–10] However, many surgeons do not consider Fiberwire suitable for zone 2 flexor repair because of its stiffness.[5] Gibson[7] reported that while non-absorbable and braided suture preference is 90% in the US, Prolene preference is 8%, and PDS preference is below 8%. In another study, it was shown that 64% of surgeons prefer Prolene and 26% prefer Ethibond suture material.[8] In our study, Turkish surgeons responded that 61% of them prefer Prolene and 29% prefer PDS. In contrast, 64% of international surgeons preferred Prolene, and 16% of them preferred Ethibond suture. Orthopedic surgeons tend to use PDS, while plastic surgeons tend to use prolene and Ethibond. These results suggested that the majority of Turkish and international surgeons prefer non-absorbable suture materials in their current practice.

Biomechanical studies have shown that the repair strength is directly proportional to the number of strands and thickness of core suture.[3,4,11,12] In the current literature, it is recommended to use 3-0, 4-0 core sutures thickness and at least 4 standard transitions.[3,11] While only 5.8% of surgeons in the US are currently performing 2-strand repair, the rest of the surgeons perform at least 4-strand repair.[7] In the UK, 34% of surgeons perform the 2-strand repair.[8] In our study, 25% of Turkish surgeons and 32% of international surgeons preferred to use 2-strand technique. Besides, the majority of the surgeons who make a 2-strand repair within the Turkish surgeons were plastic surgeons (31%). Despite the current evidence, surgeons practicing outside the US still perform 2-strand repairs. This might be attributed to the lack of awareness of the literature.

Table 3
The most common complication that required re-operation (%).

	International	Turkish
Adhesion	78	83
Rerupture	0	15
Swan-neck deformity	0	2
Quadrigia	5	0
Triggering	7	0
Lumbrical plus deformity	0	0

The epitendinous suture is used to prevent gap formation and provide additional strength in the repair side.[13–15] In the US, the choice of the epitendinous suture is 97.3%.[7] In the UK, 28% and 72% of the 5-0 and 6-0 sutures are preferred in peripheral suture selection, respectively.[8] In our study, 87% of the international surgeons and 93% of Turkish surgeons performed the epitendinous repair. Both groups frequently preferred 5-0 suture thicknesses. Almost all of the surgeons performing tendon repair in accordance with the literature also perform the epitendinous repair.

Major pulleys are the narrowest zones along the tendon pathway. The approach to the A2 and A4 pulleys, which have been proposed not to be released during flexor tendon repair, has changed. In order to ease repair and to prevent triggering, the majority of the A2 pulley and the total of the A4 pulley can be released.[4,5] However, it should be kept in mind that over loosening of the pulley may result in bowstringing.[4,5,16] In the US, 89% of surgeons perform a partial release of the A2/A4 pulley.[7] In our study, 83% of international surgeons and 98% of Turkish surgeons usually performed a partial release of the A2/A4 pulley.

Synovial fluid has an important role in tendon nutrition and friction, and repair of flexor tendon sheath contributes to tendon healing.[17] While 21% of surgeons practicing in the US perform flexor tendon sheath repair, 31% of international surgeons and 20% of Turkish surgeons perform flexor tendon sheath repair.

In order to prevent the stenosis in the Camper chiasm after the FDP repair in zone 2, it is recommended to repair the single slip of the FDS tendon with 4-strand core sutures.[18] In the US, both FDP and two slips of FDS repair frequency is 65.2% while FDP and one slip of FDS repair frequency is 26.7%.[7] The frequency of FDP and both slips of FDS repair and only FDP repair was 55% and 25%, respectively, among the Turkish surgeons. Both in the international and Turkish groups, surgeons who had less than 10 years of experience tended to perform FDP and one slip FDS repair or only FDP repair. Our study showed that experienced surgeons tended to repair both slips of FDS tendon.

Many different core suture techniques have been described in the literature.[19,20] In the US, modified Kessler is preferred by 42.3% and 4-Strand cruciate by 26.1%; while in the UK, Kessler is preferred by 36% and modified Kessler by 28%.[7,8] In our study, 65% of Turkish surgeons preferred the 4-strand modified Kessler and 30% preferred the 4-strand cruciate technique. Sebastian et al highlighted a confusion associated with the term modified Kessler, which actually refers to repairs that modify the 2-strand Kirchmayr repair.[19]

The WALANT technique has gained popularity in recent years due to advantages over other anesthesia methods. It reduces surgery time, eliminates the need for tourniquet use, and allows intraoperative evaluation of the repair.[21,22] Only 20% of surgeons in the US have used this method, and only 45% of them use this method continuously.[7] In our survey, 50% of Turkish surgeons had used WALANT, but only 20% of them used it continuously in their practice. Although the WALANT technique has many advantages, we think that the flexor tendon repair surgery is a complicated surgery and demands extensive exposures, which would eventually discourage surgeons to perform WALANT technique.

Currently, early passive or early active motion protocols are usually preferred after flexor tendon repair. While the rate of re-rupture is higher in early active motion protocols, a decrease in the range of motion is more frequently observed in the passive motion protocols.[23] There are also publications showing that the rate of re-rupture is the same in both rehabilitation protocols. Recently, there has been an increasing trend towards early active

rehabilitation protocols after flexor tendon repair.[5,23,24] Junior hand surgeons in the US prefer more active motion protocols than senior surgeons.[7] In our study, 90% of Turkish and 62% of international surgeons preferred early passive motion protocols. The majority of those who preferred early active motion protocol were plastic surgeons and most of those who preferred early passive protocol were orthopedic surgeons. Residency training had the most influence on postoperative rehabilitation preference. We believe that many surgeons have concerns about re-rupture, which hold them back from choosing early active protocols despite the current evidence.

Our study has several limitations; the number of participants in the survey was insufficient, the international respondents were mostly from Asian and Middle Eastern countries, and there was less frequent participation from western countries.

Conclusion

This study found that there are some variations in the management of zone II flexor tendon injuries between Turkish and international surgeons. However, the majority of respondents followed the current published recommendations such as a four-strand repair with epitendinous suture along with a partial release of the A2/A4 pulley.

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