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Flexor Tendon Grafting as Reoperative Procedure for Injuries within Fingers and Thumb

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Abstract

Background. The reoperation rate reported in the literature in cases of flexor tendon injuries within the fingers and thumb is about 20%, but the functional results of these reoperations are barely discussed.

The aim of the study is to evaluate the results of flexor tendon grafting performed as a reoperation in patients who had previously undergone unsuccessful flexor tendon surgery.

Methods. This study reports the outcomes of deep flexor tendon and flexor pollicis longus tendon grafting in 122 fingers of 109 patients depending on two factors — the type of the first failed surgery (tendon suture in 51 fingers or grafting in 71 fingers) and the type of the medical unit where the failed procedure had been performed (hand surgery department in 76 cases or general trauma unit in 46 cases).

Results. Our reoperative grafting procedures led to excellent results in 13 fingers of 51 (25.5% [95% CI: 14-40]) after failed tendon suture and in 32 fingers of 71 (45.1% [95% CI: 33-57]) after failed previous grafting, difference is statistically significant (χ^2 = 4.888; p = 0.027). Failed surgeries performed at the hand surgery departments were redone with 48.7% [95% CI: 37-60] of excellent results (in 37 fingers of 76) and 14.5% [95% CI: 7-24] of fair results (in 11 fingers of 76). Failed surgeries performed at the general trauma units were redone with 17.4% [95% CI: 8-31] of excellent results (in 8 fingers of 46). This value statistically significantly differed from the hand surgery department group: χ^2 = 12.054; p = 0.001. For a total, excellent results were obtained in 36.9% [95% CI: 28-46] (in 45 fingers of 122) of reoperative grafting procedures and good results in 34.5% [95% CI: 26-43] (in 42 fingers of 122).

Conclusions. Analysis of the functional results of deep flexor tendon and flexor pollicis longus tendon grafting performed as a reoperative procedure showed that the excellent results with full finger function were achievable in patients who had previously undergone unsuccessful flexor tendon surgery in zone II. But in general, the rates of motion recovery were significantly lower than in uncomplicated cases, even with a long history of injury. The worst functional results of reoperations were in patients who had previously been unsuccessfully operated in non-specialized medical units.

Keywords: ruptured flexor tendon repair, ruptured flexor tendon graft.

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Пластика сухожилия глубокого сгибателя как повторное вмешательство после неуспешного лечения повреждений в области пальцев кисти

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Реферат

Актуальность. По данным литературы, частота повторных оперативных вмешательств на сухожилиях сгибателей при повреждениях в области фиброзно-синовиальных каналов составляет около 20% и не имеет тенденции к снижению, но функциональные результаты этих повторных операций и их возможности практически не изучены.

Цель исследования — оценить результаты пластики сухожилия глубокого сгибателя пальцев и длинного сгибателя I пальца у пациентов, которые ранее перенесли неуспешные восстановительные операции по поводу повреждения сухожилий в области фиброзно-синовиальных каналов пальцев кисти.

Материал и методы. Были проанализированы функциональные результаты пластики сухожилия глубокого сгибателя пальцев и длинного сгибателя I пальца у 109 пациентов на 122 пальцах в зависимости от двух факторов — характера первого неуспешного вмешательства на сухожилиях (шов в 51 случае и пластика в 71 случае) и типа стационара, где оно было выполнено (в специализированных отделениях кисти в 76 случаях и в травматологических отделениях — в 46 случаях).

Результаты. Повторные операции после неуспешного шва сухожилий и неуспешной пластики принесли отличные результаты в 13 случаях из 51 (25,5% [95% ДИ: 14-40]) и в 32 случаях из 71 (45,1% [95% ДИ: 33-57]) соответственно, различие статистически значимо (χ^2 = 4,888; p = 0,027). После предыдущих неуспешных операций в специализированных отделениях травмы кисти наши повторные вмешательства привели к отличным результатам в 48,7% [95% ДИ: 37-60] случаев (в 37 из 76), к посредственным — в 14,5% [95% ДИ: 7-24] (в 11 случаях из 76). В тех случаях, когда предыдущее неуспешное хирургическое лечение проводилось в неспециализированных стационарах, отличные результаты после повторных вмешательств составили 17,4% [95% ДИ: 8–31], посредственные — в 34,8% [95% ДИ: 21-50] (8 из 46). Эти различия с группой пациентов, которым первая неуспешная операция была проведена в специализированном отделении травмы кисти, были статистически значимы χ^2 = 12,054; p = 0,001. В общей сложности отличные результаты получены в 36,9% [95% ДИ: 28-46] случаев (в 45 из 122), хорошие — в 34,5% [95% ДИ: 26-43] случаев (в 42 из 122).

Заключение. Анализ функциональных результатов пластики сухожилия глубокого сгибателя пальцев и длинного сгибателя I пальца, выполненной как повторное вмешательство, показал, что у пациентов, ранее перенесших неуспешные попытки восстановления сухожилий сгибателей во 2-й зоне, достижение отличных результатов с полной функцией пальцев возможно. Но в целом показатели восстановления движений оказались значительно ниже, чем в неосложненных случаях, даже при большой давности повреждения. Самые низкие функциональные результаты повторных операций оказались у пациентов, прежде неуспешно оперированных в неспециализированных лечебных учреждениях.

Ключевые слова: разрыв шва сухожилия, отрыв трансплантата сухожилия глубокого сгибателя пальцев.

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BACKGROUND

Development of modern techniques with the use of strong 2-strand looped core tendons sutures, appearance of new-generation braided suture materials, and improvement of early active mobilization protocols should all contribute to better treatment outcomes in patients with finger flexor tendon injuries. However, these results remain unstable, and the number of unsatisfactory ones does not tend to decrease from year to year [1, 2, 3], while the incidence of reoperations is 11.4-19.1% [4, 5, 6, 7]. The problem is not only that the flexor tendon surgeries are technically complicated and the result is unpredictable. There is also the high incidence of tendon injuries in the area of the fibrous synovial canals. A large number of patients face such problems and have to be operated on by hand surgeons, trauma surgeons or even general surgeons in the absence of widespread practical implementation of modern surgical and rehabilitation protocols in the regions. Thus, there are many factors hindering patients and physicians from achieving the desired treatment results and contributing to complications. Despite the plethora of articles on various issues of surgical treatment and rehabilitation of patients with finger flexor tendon injuries, there are few publications that focus on any aspects of performing reoperations required in cases of complications or failures [8, 9, 10, 11]. The results of two-stage grafting performed as a reoperative procedure in patients with burdened history are not reported separately [12, 13].

Aim of the study is to evaluate the results of deep flexor and flexor pollicis longus tendon grafting in patients who had previously undergone unsuccessful flexor tendon surgery within fibrous synovial sheaths of the fingers.

METHODS

Study design

Type of the study — retrospective cohort.

We analyzed the functional results of grafting of the deep finger flexor tendon and flexor pollicis longus tendon (FDP and FPL) of 122 fingers in 109 patients.

Inclusion criteria:

– FDP and FPL grafting was performed as a reoperative procedure, i.e. each patient had at least one unsuccessful surgical intervention for this injury of flexor tendons within fibrous synovial sheaths of the fingers and the thumb;

– reoperative grafting procedure was performed by the author of the study;

– long-term functional outcome at least 6 months after surgery is known.

All patients were allocated into two groups.

Group 1 included 70 patients who underwent the first unsuccessful surgery in a specialized hand trauma department (including our clinic). Six of them were diagnosed with the flexor tendon injury within the fibrous sheaths in two fingers. Thus, group 1 included 76 cases, an isolated injury of FDP was found in 7 cases. In the rest of cases an injury of both tendons in zone II was diagnosed.

Group 2 consisted of 39 patients initially operated on in other medical units not specialized in hand surgery. Four patients had flexor tendon damage laceration within the fibrous synovial sheaths in two fingers and one patient in four fingers. Thus, group 2 included 46 cases, an isolated injury of FDP was found in 5 patients, and the rest had injury of both tendons in zone II.

Distribution of patients by gender, age, and incidence of I-V finger injuries in both groups did not differ significantly (Table 1).

The surgical history of patients in the two groups was slightly different. There was a history of one unsuccessful operation in 75 out of 76 cases in group 1, and only one patient was unsuccessfully operated on twice. In group 2, there was one unsuccessful intervention in 37 out of 46 cases, two interventions in 6 cases, three interventions in 2 cases, and one patient had four unsuccessful operations before being examined by a hand surgeon. It should be noted that the second and all the subsequent unsuccessful surgical procedures in both groups were performed 3-12 weeks apart in most cases.

We used two groups of patients as controls. The control group, which we provisionally designated as “uncomplicated cases”, consisted of 345 patients with known functional results of the two-stage grafting of the deep finger flexor tendon and flexor pollicis longus tendon in 432 fingers performed by us without any previous interventions on flexor tendons injured in zone II. The control group, which we provisionally designated as “old injuries”, consisted of 40

patients with flexor tendon injuries of 49 fingers. In these patients, the age of injury at the time of their visit to the clinic was on average about 10 years (from 5 to 30 years), but no attempts to repair tendons had been made during this time, and the two-stage grafting of FDP performed by us was the first intervention. Characteristics of patients in the control groups are also presented in Table 1.

Assessment of result

We used the data on the long-term functional outcomes of FDP and FPL grafting, performed in all cases as a reoperative procedure. Results had been evaluated at the follow-up examination of patients according to the scheme accepted in the clinic and based on the five-point system of V.I. Rozov: excellent, good, fair, contracture and graft failure [14]. An excellent result was defined as complete restoration of active finger flexion with full or almost full extension (deficit of no more than 5°); good — complete restoration of active flexion with slight limitation of extension; fair — limited finger flexion with both full and limited extension. Results were analyzed according to two factors: the nature of the first unsuccessful tendon operation (suture or grafting) and the type of the unit where it was performed (specialized or non-specialized).

In the control groups "uncomplicated cases" and "old injuries" the results of tendon grafting have been evaluated according to the same scheme. They are presented in Table 2.

Statistical analysis

Data are presented in absolute values and percentages, 95% confidence interval (CI) was calculated using the Klopper-Pearson method. Pearson's chi-square test was used to assess the statistical significance of differences.

Table 1

Characteristics of study groups

Parameter		Group 1	Group 2	"Uncomplicated cases" group	"Old injuries" group
Number of patients/fingers		70/76	39/46	345/432	40/49
Gender	f	13	10	76	17
	m	57	29	269	32
Age, y.o.	range	18-64	19-67	15-76	18-72
	mean	35.5	38.3	36.3	39.5
Injured finger	thumb	3	2	9	–
	index	27	11	60	10
	middle	26	7	86	10
	ring	5	13	134	14
	little	15	13	143	15

Table 2

Results of flexor tendon grafting in control groups

Group	Result				
	Excellent	Good	Fair	Contracture	Graft failure
Uncomplicated cases	264 (61.1% [95% CI: 56-66])	97 (22.4% [95% CI: 19-27])	32 (7.4% [95% CI: 5-10])	8 (1.9% [95% CI: 0-3])	31 (7.2% [95% CI: 5-10])
Old injuries	23 (46.9% [95% CI: 33-62])	19 (38.8% [95% CI: 25-54])	4 (8.2% [95% CI: 2-20])	2 (4.1% [95% CI: 0-14])	1 (2.0% [95% CI: 0-11])

RESULTS

The indications for reconstructive-restorative reoperative procedures in our clinic, i.e., the most frequent complications of the first surgery for flexor tendon injuries that had resulted in failure, were tendon graft avulsion rupture — 63 (51.6%) cases, tendon suture rupture — 44 (36.1%), and flexor flexion contractures of the fingers, including those with scar tissue deformity of the skin and pulley failure — 15 (12.3%) cases.

The first identified difference between the two groups of patients relates to the method of FDP and FPL grafting. In group 1, the condition of the fibrous synovial sheath of the finger at the time of reoperation allowed to perform a one-stage grafting in 44 of 76 cases (57.9 [95% CI: 46-69]%). In the remaining 32 cases (42.1 [95% CI: 31-54]%), a two-stage grafting was carried out as the condition of the fibrous synovial sheath required tendon replacement with a silicone prosthesis insertion at the first stage of reconstruction. Additional intervention as a separate stage was performed only in one case, which was the reconstruction of the A2 pulley with an autograft from the extensor digitorum longus tendon of the toes.

In group 2, the condition of the fibrous synovial sheath was suitable for performing one-stage grafting in only 9 out of 46 cases (19.6% [95% CI: 9-34]), while two-stage FDP and FPL grafting was necessary in the remaining 37 cases (80.4% [95% CI: 66-91]). These data indicate significant differences in the status of the fibrous synovial sheath of the fingers between patients in groups 1 and 2 (χ^2 = 17.135; d.f. 1, p<0.0001). In addition, in the group 2, 17 cases required additional separate interventions: Z-plasty in 9 cases, correction of the swan neck deformity in 3 cases, grafting of soft tissue scar defect with a cross-finger flap in one case, and application of distraction apparatus to eliminate arthrogenic flexion contracture of the finger in 4 cases.

When comparing the results of our grafting reconstructive procedures in those cases where the first unsuccessful operation was tendon suture (51 cases from both groups) and those 71 cases from both groups where the first unsuccessful operation was FDP and FPL grafting, we found out that reoperations after unsuccessful tendon suture and after unsuccessful grafting yielded excellent results in 13 cases out of 51 (25.5% [95% CI: 14-40]) and 32 cases out of 71 (45.1% [95% CI: 33-57]), respectively. This difference is statistically significant (χ^2 = 4.888; d. f. 1, p = 0.027). Good results were obtained in 19 cases of 51 (37.3% [95% CI: 24-52]) and 23 cases of 71 (32.4% [95% CI: 22-45]), and fair results were obtained in 13 cases of 51 (25.5% [95% CI: 14-40]) and 14 cases of 71 (19.7% [95% CI: 11-31]), respectively. The incidence of contractures after FDP and FPL grafting in patients with a history of unsuccessful tendon suture was 3.9% [95% CI: 0-13] (2 cases out of 51), while there were no contractures after FDP and FPL grafting in patients with a history of failed grafting. The incidence of graft failure was 7.8% [95% CI: 2-19] (4 cases out of 51) and 2.8% [95% CI: 0-10] (2 cases out of 71), respectively (Fig. 1).

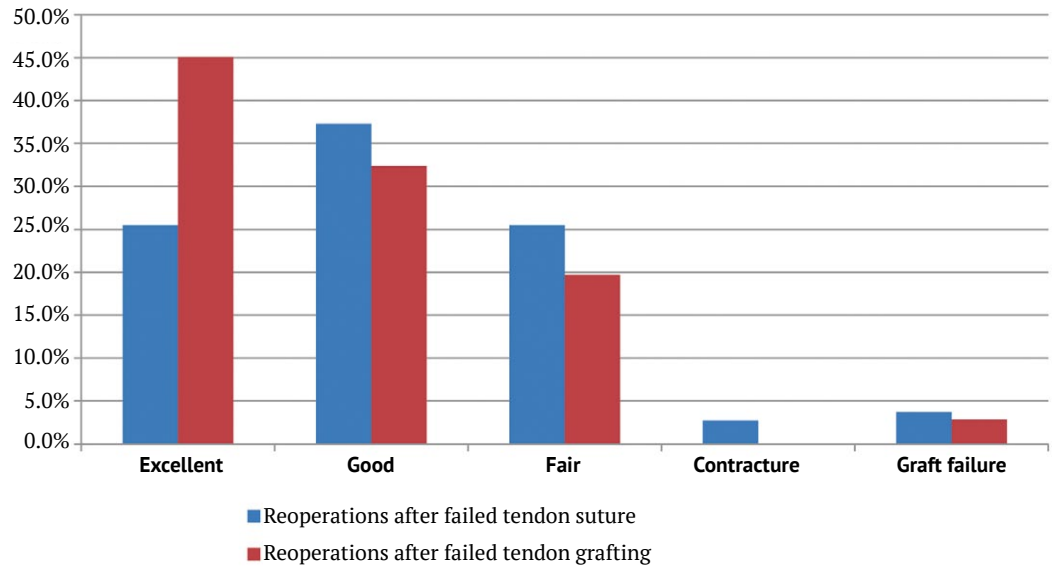

Fig. 1. Flexor tendon reoperation results depending on the type of the first unsuccessful procedure

We analyzed the results of FDP and FPL grafting according to the type of medical unit of the first unsuccessful surgery. It was determined that 48.7% [95% CI: 37-60] of patients with previous unsuccessful operations in specialized hand surgery units had excellent results (37 cases of 76), 34.2% [95% CI: 24-46] had good results (26 cases of 76), 14.5% [95% CI: 7-24] had fair results (11 cases of 76) and 2.6% [95% CI: 0-9] of patients experienced graft failure (2 cases of 76). There were no contractures. Patients treated in non-specialized hospitals had excellent results in 17.4% [95% CI: 8-31] of cases (8 cases out of 46); this parameter statistically significantly differed from group 1: $\chi^2 = 12.054$; d.f. 1, p = 0,001. Good results in this group were obtained in 16 cases out of 46 (34.8% [95% CI: 21-50]), fair results were also obtained in 16 cases out of 46 (34.8% [95% CI: 21-50]). The difference from group 1 was also statistically significant: $\chi^2 = 6.858$; d.f. 1, p = 0,009. The incidence of graft failure was 8.7% [95% CI: 2-21] (4 cases out of 46) and the incidence of finger flexion contractures was 4.3% [95% CI: 0-15] (2 cases out of 46) (Fig. 2).

In total, excellent results of FDP and FPL grafting, performed as a reoperative procedure in patients with burdened surgical history, were obtained in 45 of 122 cases (36.9% [95% CI: 28-46]), good results in 42 of 122 cases (34.5% [95% CI: 26-43]), and fair results in 27 of 122 cases (22.1% [95% CI: 15-30]). The incidence of contractures was 1.6% [95% CI: 0-6] (2 cases of 122), and the incidence of graft failure was 4.9% [95% CI: 2-10] (6 cases of 122). The ratio of excellent to good results of reoperations in total was 1.07. In group 1, the ratio of excellent to good results was 1.4, in group 2 this ratio was 0.5.

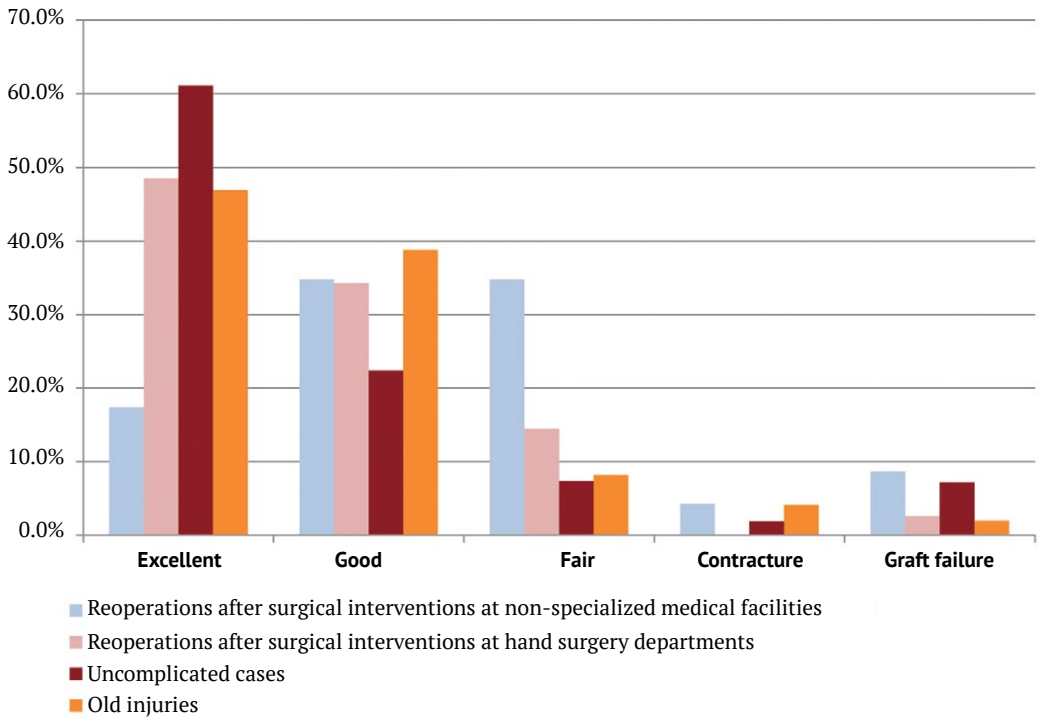

Fig. 2. FDP and FPL tendon grafting results in compared groups

DISCUSSION

Finger flexor tendon injuries are very common, so primary reconstructive surgeries are performed not only by hand surgeons, but also by trauma surgeons or even general surgeons. It is obvious that the statistics of complications and failures that are given in the publications of expert class hand surgeons in highly specialized journals and the number of unsatisfactory treatment outcomes in real life are different, but few specialists pay attention to it [4]. Perhaps this may be partly the reason why the tactics of further treatment of patients with complications are not discussed in the literature, with few exceptions [11, 12, 15]. What interventions can and should be performed and in what time

frame, what results should be expected, what can and cannot be corrected — these questions are not only remain unanswered, they are not even posed. The situation with immediate repeated repair of finger flexor tendons after rupture of the primary suture within the fibrous synovial sheaths is somewhat better covered in the literature. Based on the evaluation of the results obtained (21% excellent, 24% good, 12% fair, 31% poor, and 12% repeated failures), M.B. Dowd et al. recommend abandoning completely the immediate attempts to re-suture the flexor tendons of the little finger, and in case of the injury to other fingers, not esteeming this tactic as the method of choice and firstly considering all possible alternatives in each specific case [16]. Due to increasing risk of scar adhesions at reoperative procedures on flexor tendons within the fibrous synovial sheaths, A. Poggetty et al. as an alternative to "biological reconstruction" (two-stage tenoplasty with temporary prosthesis) even suggest that such patients should be provided with an active reinforced silicone tendon prosthesis as a permanent one, i.e. without its subsequent replacement with a tendon autograft. However, the reported long-term outcomes (out of 19 outcomes, 9 poor, 2 excellent, 3 good, and 5 fair) do not yet demonstrate significant benefits of this technology [11].

Specialists advise to be always prepared for unpleasant surprises when performing reoperations on flexor tendons [12]. Our study shows that previous unsuccessful interventions have a negative impact on the condition of the entire gliding apparatus of the finger. For this reason, tenoplastic surgeries in such patients require a patient-specific surgical treatment plan with adjustments to the usual tactics, as well as the use of non-standard techniques that consider the irreversible anatomical disorders of connective tissue structures of the fingers and enable their correction or compensation, if possible. Not only soft tissue scars and damage to the structures of the fibrous synovial sheath, but also changes in the capsular-ligamentous apparatus of the joints and imbalance of the extensor apparatus of the finger create new and extremely unfavorable conditions for the regeneration and functioning of the graft.

To better understand the possibilities of reconstructive reoperations on flexor tendons and to critically evaluate our findings, we compared them with our own existing data on two-stage FDP and FPL grafting in 432 uncomplicated cases and 49 cases of old tendon injuries with no history of attempted reconstructive surgeries (see Fig. 2). Excellent to good results ratio in the group of uncomplicated injuries is 2.7 and significantly exceeds the corresponding value for reoperations. Even in the group of old injuries, the ratio of excellent to good results is 1.21, i.e. greater than one, and thus fundamentally differs from the ratio in the group of patients with a history of unsuccessful tendon surgeries in non-specialized units. Thus, the results of our study show that unsuccessfully surgically treated flexor tendon injuries are not just old cases and the prognosis of subsequent grafting procedures is worse for them.

Analyzing treatment results of patients, we came to the conclusion that it is always desirable, and in most cases, it is simply necessary to postpone reoperation until maturation and softening of soft tissue scars, subsidence of swelling and full restoration of passive flexion in all finger joints. Otherwise, as a result of frequent surgical interventions in a short period of time, the regeneration processes are irreversibly disrupted with the formation of flexion contracture of the finger. Patient follow-up during preoperative preparation, repeated examinations, in addition to their main task, which is to train motions of the fingers' joints, give the surgeon the opportunity to solve another very important problem — to understand how motivated the patient is, whether they are is ready for a complex and long postoperative rehabilitation and, most importantly, how adequate their demands are. Results of our study show that, on the one hand, the possibilities of tendon reoperations in terms of obtaining a perfect result are limited, but, on the other hand, restoration of full function of the fingers is achievable. With this in mind, indications for reoperation in complicated cases should be determined strictly and on the case-by-case basis. All patients with surgical failures require particularly attentive and sensitive attitude. We have developed the following rules of interaction with the patients based on our own experience. If we consider the second re-operation to be indicated, i.e. we are sure of its success, we explain to the patient in a clear and friendly manner

all the facts of the matter (number, timing and details of the expected surgical steps, possible risks, anesthesia options, length of hospital stay, wearing of bandages and rehabilitation period, expected result in comparison with a healthy finger, etc.) and let the patient make the final decision on whether to undergo the operation or not. When a surgeon does not see real possibilities to surgically improve the function and appearance of the finger, especially in patients with inadequate expectations who are convinced that everything can be redone and restored to its former state and it is only a matter of the surgeon's competence and desire, then the surgeon should be able to firmly say "no".

Results of this study suggest that staged surgery with separate planning for elimination of tenodesmogenous contracture of the finger prior to provisional silicone deep flexor tendon prosthesis placement is a reliable tactic for repeated reconstructions that increases their effectiveness, consistently yields predictable results, and reduces the risk of complications. We believe that it was the allocation of contracture elimination into a separate stage and insertion of silicone tendon prosthesis only after restoration of good passive motions in the interphalangeal joints of the finger that allowed us to obtain better results than H. Sakellarides [15], who combined finger contracture release and FDP prosthesis placement in one surgical stage. He obtained 14% excellent and 33% good results in a group of 40 patients. The author considered an active flexion deficit of 1 cm or less to be an excellent result, and no more than 1.5 cm deficit to be a good result, whereas we treated any active flexion deficit as a fair result.

Facts established when analyzing the long-term results make us suggest some, in our opinion, reasonable measures to prevent the increase in the number of reoperations. In finger flexor tendon injuries, primary reconstructive surgery should be performed only by a specialist experienced enough in hand surgery who knows modern techniques, regularly performs surgeries, observes and controls the rehabilitation of his patients, follows his long-term results and analyzes them, and constantly accumulates clinical experience. This is the point of view held by well-known modern specialists in the field of primary repair of finger flexor tendons [17]. A surgeon with little experience in treating patients with flexor tendon injuries should know that refusal of a primary flexor tendon suture within fingers in favor of planned treatment does no harm to the patient, while a hastily and incompetently performed surgery and the subsequent complications can cause irreparable harm to the patient. In case of failure of the initial procedure (suture rupture, contracture, etc.), reconstructive reoperation on the intrasynovial section part of the deep flexor tendon and flexor pollicis longus tendon should be performed only by a hand surgeon in a specialized hand surgery center (department), and not by a trauma or general surgeon.

We would like to emphasize that the surgery of finger flexor tendon injuries within the fibrous synovial sheaths is an area where no one is safe from failure, even expert specialists. But many years of our experience show that it is possible to correct the situation and eventually obtain more or less full range of motion only in cases where no serious technical errors had been made during the first operation. Otherwise, all subsequent reconstructions become palliative. Successful reoperative grafting procedure of the deep flexor tendon is considered to be one of the most exquisite and satisfying operations in all hand surgery.

CONCLUSIONS

Analysis of the functional results of deep finger flexor tendon and flexor pollicis longus tendon grafting performed as a reoperative procedure showed that it was possible to achieve excellent results with full finger function in patients who had previously undergone unsuccessful attempts of flexor tendon reconstruction surgery within the fibrous synovial sheaths. However, in general, the rates of motion restoration were significantly lower than in "uncompromised" cases, even in cases of old injury. The worst functional results of reoperations were found in patients who had previously been operated on unsuccessfully in non-specialized medical units.

DISCLAIMERS

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