Original Article
The therapeutic effects of the minimally invasive repair of hand flexor tendon injuries

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Abstract: Objective: To compare the therapeutic effects of the minimally invasive repair and conventional therapy of hand flexor tendon injuries. Methods: This study recruited 98 patients with flexor tendon injuries of the hand who were randomly divided into a control group (49 patients who received traditional surgery) and an experimental group (49 patients who were treated with minimally invasive repair). The excellent and good treatment rates, the complication rate, the visual simulation self-assessment scale (VAS) score, the patient satisfaction rate, and the short form 36 questionnaire (SF-36) scale were compared between the two groups. Results: The excellent and good treatment rates, the patient satisfaction rate, and the SF-36 scale in the experimental group were significantly higher than they were in the control group (all P<0.05). Meanwhile, the complication rate and the VAS score in the experimental group were significantly decreased compared with the control group (all P<0.05). Conclusion: For patients with flexor tendon injury, a minimally invasive repair can effectively improve hand function, reduce the incidence of complications, and raise the quality of life. A surgery with a high patient satisfaction rate, minimally invasive repair is worth promoting.

Keywords: Hand flexor tendon injury, minimally invasive repair, excellent and good treatment rates, complications

Introduction

The hand is the most flexible organ of the human body. The tendon of the hand plays an important role in maintaining the normal functions of the fingers, including free movement, stretching, flexion, etc. Damage of the tendon of the hand can seriously impact patients’ work and lives [1, 2]. It is reported that hand trauma accounts for 30% of injuries commonly seen in clinical practice [3]. The repair capacity of traditional surgery is limited. The tendon consists of the deep and superficial tendons. Traditional surgery excises the superficial tendon, but not the deep tendon. The deep tendon only needs to be sutured. The blood supply of the deep tendon is closely related to the superficial tendon. Therefore, the traditional surgical removal of the superficial tendon influences the blood supply of the deep tendon, resulting in an insufficient blood supply and an unsatisfied therapeutic effect [4, 5]. In order to improve the hand functions of patients with flexor tendon injuries as much as possible, both the deep and superficial tendons need to be preserved during surgery [6, 7].

With the development of minimally invasive surgery, the advantages of the minimally invasive repair of the tendon gradually become apparent, including less trauma and a quick recovery. This surgery, which is highly recognized and endorsed by physicians, preserves the integrity of tendon sheath and trochlea to the greatest extent, reducing damage to the synovial membrane [8]. Here, a retrospective analysis of clinical data was performed for 98 patients diagnosed with hand flexor tendon injury at the Wendeng Orthopaedic and Traumatologic Hospital of Shandong Province from February 2017 to February 2019.

Materials and methods

General information

This study was approved by the Ethics Committee of Wendeng Orthopaedic and Trauma-
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tologic Hospital of Shandong Province and recruited 98 patients diagnosed with hand flexor tendon injury in Wendeng Orthopaedic and Traumatologic Hospital of Shandong Province from February 2017 to February 2019. These patients were randomly divided into a control group (49 patients who received traditional surgery) and an experimental group (49 patients who were treated with minimally invasive repair).

Inclusion criteria: Patients who consented to traditional surgery or minimally invasive repair; patients who were diagnosed with hand flexor tendon injury by MRI and CT; patients who could communicate normally; patients and their families who were aware of this study and signed the informed consent form.

Exclusion criteria: Women who were lactating or pregnant; patients who received relevant treatment prior to enrollment; patients with impaired kidney and liver function; patients with blood system diseases and surgical contraindications; patients who had serious psychological, cognitive, or mental disorders; patients with malignant tumors; patients with heart and respiratory failure.

Methods

The control group (the patients who received traditional surgery): After admission, the patients received wound treatments, such as disinfection, cleansing, and hemostasis in a timely fashion. The incision location was selected according to the actual condition of patient’s injury. After successful anesthesia, the injury sites of the deep and superficial tendons were sutured (Figure 1).

The experimental group (the patients who were treated with minimally invasive repair): After enrollment, the patients received wound treatments, such as disinfection, cleansing, and hemostasis in a timely fashion. The location and extent of the injury were defined before the surgery. The impaired parts of the blood vessels were anastomosed using a microsurgical instrument. Flexion and straight are the main types of tendon injury. For patients with a straight type injury: The proximal end of the tendon rupture was pulled along the tendon sheath, and the fracture site was then fixed; the tendon and damaged extima were sutured using the Kessler method. For patients with a flexion type injury: An incision was made at a distance of 0.5 cm from the fracture site; the length of the incision was 2-3 cm; the whole procedure included cutting the sheath, suturing, pulling, fixing the proximal fracture site, loosening the tourniquet, and fixing with plaster (Figure 2) [5, 6].

Outcome measures and evaluation criteria

The excellent and good treatment rates, the complication rate, the VAS score, the patient satisfaction rate, and the SF-36 scale were compared between the two groups.

The criteria for excellent and good treatment rate included: The total active motion (TAM) close to the healthy side was judged as excellent; the TAM close to 75% of the healthy side was judged as good; the TAM close to 50% of the healthy side was judged as fine; the TAM
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### Table 1. Comparison of the basic data

<table>
<thead>
<tr>
<th>Group</th>
<th>Experimental group (n=49)</th>
<th>Control group (n=49)</th>
<th>χ² value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (n)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>29</td>
<td>27</td>
<td>0.167</td>
<td>0.683</td>
</tr>
<tr>
<td>Female</td>
<td>20</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>48.62±5.44</td>
<td>48.71±5.41</td>
<td>0.082</td>
<td>0.935</td>
</tr>
<tr>
<td>Mean duration of injury (hours)</td>
<td>6.15±0.68</td>
<td>6.11±0.64</td>
<td>0.299</td>
<td>0.765</td>
</tr>
<tr>
<td>Type of injury (n)</td>
<td></td>
<td></td>
<td>2.872</td>
<td>0.238</td>
</tr>
<tr>
<td>Contusion</td>
<td>18</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric saw injury</td>
<td>20</td>
<td>29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cutting injury</td>
<td>11</td>
<td>11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

close to or less than 50% of the healthy side was judged as poor. Excellent and good treatment rate = (excellent cases + good cases)/total cases in each group * 100.00% [9].

Complication rate: The tendon adhesion, joint stiffness, and infection rates were calculated.

VAS: The total score was 10 points; no pain was 0 points, severe pain was 10 points; the higher the score, the greater the pain [10].

The patient satisfaction rate was evaluated based on the departmental self-made questionnaire: The total score was 100 points: very satisfied (≥80 points); satisfied (≤79 points and ≥60 points); unsatisfied (≤59 points). Total satisfaction rate = (very satisfied cases + satisfied cases)/total cases in each group * 100.00%.

Quality of life, including mental health, activity, general health status, social ability, physical pain, and physiological and emotional functions were assessed using the SF-36 scale. The higher the score, the better the quality of life [11, 12].

### Statistical methods

All data were analyzed using SPSS statistical software version 25.0. The measurement data were expressed as the mean ± standard deviation, and a paired t-test was applied for the intergroup comparisons, and an independent sample t test was used for comparisons between the two groups and were calculated (X ± sd). The enumeration data were calculated as number/percentage (n/%); the comparisons were conducted using a chi-squared test. The difference was statistically significant when the P value was less than 0.05.

### Results

#### Basic data

As shown in Table 1, there were no significant differences concerning gender, mean age, mean duration of injury, or type of injury between the two groups (all P>0.05).

#### Excellent and good treatment rate

As displayed in Table 2, the excellent and good treatment rates in the experimental group were significantly higher than they were in the control group (92.92% vs. 73.47%, P<0.05).

#### Complication rate

The complication rate in the experimental group was decreased more than it was in the control group (4.08% vs. 20.41%, P<0.05, Table 3).

#### VAS score

As illustrated in Table 4 and Figure 3, though the VAS scores were significantly decreased in both groups after the treatment when compared with the scores before treatment, after the treatment, the VAS score in the experimental group was significantly lower than it was in the control group (P<0.05).

#### Patient satisfaction rate

As shown in Table 5, the patient satisfaction rate in the experimental group was significantly increased compared with the rate in the control group (93.88% vs. 71.34%, P<0.05).

#### SF-36 scale

Though the SF-36 scale scores were significantly increased in both groups after the treatment when compared with the scores before treatment, the SF-36 scale score in the experimental group after treatment was significantly higher than it was in the control group (P<0.001, Table 6).
Flexor tendon injury is a common type of hand injury, accounting for about 30% of hand injuries. Most flexor tendon injuries are the open type. Patients also generally have bone and joint injuries, nerve vascular injuries, etc. Therefore, it is prone to deteriorate to a closed lac-
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In this study, we found that the excellent and good treatment rates, the satisfaction rate, and the SF-36 scale in patients who received minimally invasive repair were significantly higher than those treated with the traditional operation, while the complication rate and VAS score were significantly decreased. In a study reported by Jin et al., the excellent and good treatment rates of the minimally invasive repair therapy and traditional surgery were 88.64% and 65.91%, respectively [20]. It is obvious that their results are similar to ours. Therefore, we can conclude that minimally invasive repair is of high effectiveness and safety.

It should be noted that minimally invasive repair should be strictly conducted at an appropriate time. The sooner, the better. The force used to suture the lesions plays an important role in determining the result of the surgery. It is quite easy for it to fall off when the force is weak. However, it is prone to prolonging the healing time when the force is too strong. Similarly, the plaster should be fixed with appropriate force. The local blood flow can be easily affected when the force is too strong. However, the probability of shedding can be increased when the force is too weak [21, 22]. Moreover, patients with flexor tendon injury of the hand should do functional exercises as early as possible. Exercise can enhance the ability of the epitendineum cells to synthesize collagen, improving hand function and minimizing the rate of tendon adhesion. Additionally, in order to reduce the rate of tissue adhesion after surgery, doctors should avoid cutting the tendon directly with a clamp as much as possible.

The shortcomings of this study are no follow up data and a limited number of included patients, which may cause a bias in the results. In order to provide a more scientific reference for the evaluation of therapeutic efficacy and the safety of minimally invasive repair of hand flexor tendon injury, we will perform a multicenter prospective study with an increased sample size and a long follow up period.

In summary, minimally invasive repair can improve the hand functions of patients with flexor tendon injury significantly. At the same time, it can reduce postoperative complications, relieve pain, and improve quality of life. A surgery with high patient satisfaction, minimally invasive repair is worth promoting.

Disclosure of conflict of interest

None.

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References


<p>| Table 5. Comparison of the patient satisfaction rate (n, %) |
|---------------------------------|----------------|----------------|----------------|----------------|</p>
<table>
<thead>
<tr>
<th>Group</th>
<th>Very satisfied</th>
<th>Satisfied</th>
<th>Unsatisfied</th>
<th>Very satisfied and satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental group (n=49)</td>
<td>20 (40.82)</td>
<td>26 (53.06)</td>
<td>3 (6.12)</td>
<td>46 (93.88)</td>
</tr>
<tr>
<td>Control group (n=49)</td>
<td>14 (28.57)</td>
<td>21 (42.86)</td>
<td>14 (28.57)</td>
<td>35 (71.43)</td>
</tr>
<tr>
<td>χ² value</td>
<td>8.612</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P value</td>
<td>0.003</td>
<td></td>
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<td></td>
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</table>

<p>| Table 6. Comparison of the SF-36 scale score (X ± sd) |
|---------------------------------|--------------|--------------|--------------|--------------|</p>
<table>
<thead>
<tr>
<th>Group</th>
<th>Before treatment (score)</th>
<th>After treatment (score)</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental group (n=49)</td>
<td>58.86±3.57</td>
<td>88.85±9.47</td>
<td>20.725</td>
<td>0.000</td>
</tr>
<tr>
<td>Control group (n=49)</td>
<td>58.84±3.63</td>
<td>70.14±5.04</td>
<td>12.724</td>
<td>0.0000</td>
</tr>
<tr>
<td>t</td>
<td>0.028</td>
<td>12.209</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.978</td>
<td>0.000</td>
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</table>
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