Results of the second toe autotransplantation for thumb reconstruction


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Abstract

Defects of the thumb negatively impact physical and mental health, lead to depression, inferiority complex and hopelessness in the future. The aim of the study was to explore long-term results of thumb reconstruction using autologous transplantation of the second toe with microvascular anastomoses. Material and methods Second toe transplantation for thumb reconstruction was performed for 54 patients. There were 48 male and 6 female patients aged from 12 to 55 years. When analyzing the long-term results of surgical treatment of patients. The anatomy and functionality of the repaired finger was evaluated at a long term measuring the range of motion in the joints, muscle strength of the hand and major types of hand grips. Results The autograft completely healed with opposition of the reconstructed thumb and the rest fingers restored in 51 patients. The autograft failed in three cases treated with less functional methods. Conclusion Microsurgical reconstruction technologies used for a lost thumb facilitated rapid recovery of the finger and significantly improved functions of the injured hand as an entity. Free second toe transplantation using microvascular anastomoses for the thumb reconstruction allowed the patient regain basic gripping functions and improve cosmesis of the injured hand.

Keywords: microsurgery, plastic surgery, reconstruction, toe transplantation, thumb, defect


INTRODUCTION

Traumatic finger amputation due to necrosis of soft tissues lead to persistent impairment of the hand function in 70–80 % of the cases. Absence of the thumb is the reason for a 50 % decrease in working capacity, and significant effort has been focused on thumb reconstruction [1–12]. The reconstructive thumb must have an aesthetic appearance, sufficient length and full sensitivity and provide hand grips. The opposability of the human thumb is its unique ability to oppose the other four fingers performing subtle kinematic movements. The reconstruction technique of the thumb to maximally regain aesthetic attractiveness and functionality of the injured hand would depend on the length of the stump and the condition of the tenar muscles [2, 3, 7, 9, 13–23]. Thumb reconstruction is essential for younger patients who lose the ability to perform professional, household and social duties with traumatic thumb loss and that urges surgeons look for optimal treatments to solve the problem [24–39].

MATERIAL AND METHODS

Second toe transplantation to the thumb position was performed for 54 patients. The patients had severely impaired grip function and deviations in the psycho-emotional state due to the loss of stereotypical motor hand movements: from unmotivated irritability to unsociability, in females, in particular.

The inclusion criterion was an amputated stump of the thumb in subacute and long-term periods of injury in patients aged 12 to 55 years. The exclusion criteria were decompensated somatic pathology; infectious processes in the injured hand; mental, neurological and vascular diseases in the decompensation stage; cold injuries that led to necrosis of the fingers and toes. The reasons for the thumb loss were traumatic separations, extensive destruction of soft tissues in the workplace or at home. There were 48 male and 6 female patients. Preoperatively, patients underwent physical and radiographical examination of the injured hand and USGD of major arteries of the involved and the donor lower limbs; age (younger than 55 years), time of injury, the dominant hand, occupation, comorbidities were considered. The skin, scars, joint mobility, pulsation of the major arteries of the limbs, functioning of the apocrine glands of the donor foot were evaluated during physical examination.

The upper limb and the hand function and activity limitations were assessed preoperatively with the Disabilities of the Arm, Shoulder and Hand Questionnaire (DASH) that consisted mainly of a 30-item disability/symptom scale.
RESULTS

A positive result at a long term was obtained in 51 patients. The autograft failed to survive in three patients who were treated with less functional methods to improve the thumb function. The anatomy of the thumb reconstruction, the extent of the functionality regained in the injured hand, range of motion in the joints of the thumb, the muscle strength of the hand, major types of hand grip (DASH score, A.I. Kapanji score, the quality of life assessed with the SF-36 scale) were evaluated at a long term. The statistical analysis of the outcomes allowed for identifying significance of the results. Statistically significant improvement of the parameters of the injured hand was observed postoperatively with increased range of motion, improved grips and strength test loads. Assessment of the restored anatomy, the range of motion in the thumb (flexion and extension) and major types of hand grip revealed a significant improvement of the parameters in the postoperative period (p < 0.01) (Table 1).

Table 1

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<th>Preoperative and postoperative hand grip strength</th>
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<td><strong>Preoperatively</strong></td>
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<tr>
<td>Spherical grip (χ² Macnamara (A/D) 0.1, p = 0.75; (B/C) 24.04, p &lt; 0.001)</td>
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<tr>
<td>Hook grip (χ² Macnamara (A/D) 4.08, p = 0.043; (B/C) 22.04, p &lt; 0.001)</td>
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<tr>
<td>Limited grip (χ² Macnamara (A/D) 1.45, p = 0.23; (B/C) 23.04, p &lt; 0.001)</td>
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<tr>
<td>Cylindrical grip (χ² Macnamara (A/D) 0.8, p = 0.37; (B/C) 29.03, p &lt; 0.001)</td>
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<tr>
<td>Opposition (χ² Macnamara (A/D) 0.25, p = 0.62; (B/C) 30.03, p &lt; 0.001)</td>
</tr>
<tr>
<td>Pinch grip (χ² Macnamara (A/D) 1.50, p = 0.220; (B/C) 29.03, p &lt; 0.001)</td>
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Dynamometry parameters improved significantly in the postoperative period (p < 0.01). The upper limb function was shown to improve at a long term according to the Kapanji score (p < 0.01) with the range of motion measuring 7.17 ± 1.42. A comparative assessment of the outcomes of the thumb reconstruction with the DASH score also revealed statistically significant differences between preoperative and postoperative measurements (p = 0.019) 2.3 ± 0.34. Evaluation of the quality of life on the SF-36 scale revealed significant postoperative improvements in physical functioning, role physical functioning, mental health, vitality and role emotional functioning (p < 0.05). High levels of personal (46.6 points) and reactive anxiety (34.5 points) were measured preoperatively with the Spielberger-Khanin anxiety test. Postoperatively, the level of personal anxiety measured 18 points and reactive anxiety was 37.8. General health and physical functioning improved after the operation. Patients showed a slight increase on the scales of role, social, emotional functioning, the scale of vitality, mental health and pain that indicated improvement in the quality of life after treatment.

A clinical example A 45-year-old patient V. presented with the thumb loss on the right side due to an occupational injury he had received 3 weeks ago (Fig. 1). The patient underwent surgery of free transplantation of the second toe on the left side to the position of the missing thumb using microvascular anastomoses (Fig. 2). Postoperative period was uneventful and the autograft survived. The patient could produce all types of hand grips at 10-year follow-up with the sensitivity completely restored in the thumb (Fig. 3).

All patients indicate the significant attractiveness of the hand with reconstructive thumb: "the hand looks like the hand."
Fig. 2 Surgical stages: (a) planning surgical approach on the donor foot; (b) vascularized autograft; (c) arterial anastomosis applied; (d) venous anastomosis applied

Fig. 3 Appearance (a–d) and radiograph of the right hand (e) at a long term

DISCUSSION

Planning of treatment for patients with post-traumatic defects of the thumb should be based on early reconstructive interventions of damaged structures that would optimize the patient’s adaptation to the social environment, help to restore professional skills and household functionality [5, 6, 7, 9, 15, 16, 21, 23]. Many authors prefer using methods of plastic surgery with skin-bone flaps and the soft-tissue component of the newly formed thumb to be restored with the Filatov stem, the double Converse-Blokhin flap, a non-free inguinal tubular flap in thumb reconstruction. The bone frame of the thumb is formed using a fragment of the iliac crest or radius. Such methods are characterized by multi-stage treatment and cause a lot of inconvenience for patients in the form of a long-term malpositioned limb and the development of joint stiffness, maceration sites and partial skin necrosis. The aesthetic appearance of the hand during thumb reconstruction using the above flaps leaves much to be desired. The major disadvantage of using such flaps is thought to be lack of joints in the new thumb necessary to perform various hand grips. Inability to restore the sensitivity of the flap is a significant disadvantage of thumb reconstruction using skin and bone grafts [2, 8, 11, 12, 14, 22, 24].
The above disadvantages can be avoided with the use of free transplantation of the second toe on microsurgical anastomoses for thumb reconstruction. The technique allows one-stage thumb reconstruction with complete restoration of all anatomical structures necessary for adequate functioning and significant aesthetic appearance of the hand. Autograft necrosis can be a significant disadvantage of thumb reconstruction based on free transplantation of the second toe using microsurgical anastomoses. It would either do everything or nothing. An experienced surgical team is essential [1, 4, 5, 6, 7, 9, 16, 17, 21, 33, 37]. Interpretation of long-term outcomes of treatment based on evidence-based medicine showed a paramount role of reconstructive surgery of the fingers in restoration of the thumb function and appearance of the hand [1, 3, 5, 6, 9, 10, 16, 17, 20, 21, 23, 27, 32, 36].

Thus, the complexity of reconstructive operations on the thumb often pushes specialists to make a simpler decision and use methods of skin-bone reconstruction that do not suggest restoration of the joints of the new thumb and reconstruction of the hand grips and negatively affects functional aspects of the hand. Surgical treatment of patients with the thumb loss should be targeted at anatomical reconstruction of the thumb and restoration of the kinematics of hand movements with professional, household and social reintegration of patients. Optimization of treatment of patients with post-traumatic defects of the thumb based on transplantation of the second toe as an entity has important scientific and applied significance and is a promising trend.

CONCLUSION

Analysis of the available modern literature demonstrates that there is controversy in the choice of the type and timing of surgical treatment of patients with a lost thumb. The parameters to be evaluated at a long term of thumb reconstruction include reconstructive anatomy and aesthetic appearance; restoration of the necessary amplitude of movements in the thumb joints, major grip types and the strength of the hand. Transplanting the second toe to the position of the missing thumb facilitated rapid recovery of the finger.

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