J Musculoskelet Neuronal Interact 2024; 24(1):90-96

Journal of Musculoskeletal and Neuronal Interactions JMNI

Original Article

Application of Digital Artery Transposition in the Replantation of Severed Fingers with Vessel Defects and its Influence on Nerve Function and Joint Function Recovery

Chunlai Xiao, Genqiang Bao, Guohui Zhang, Yulong Guan, Quan Wang, Hua Li

Department of Hand and Foot Surgery, Hengshui People's Hospital, Hengshui, China

Abstract

Objective: To investigate the application of digital artery transposition in replanting severed fingers with vascular defects and its impact on nerve and joint function recovery. **Methods**: 200 patients who received replantation of severed fingers were randomly divided into artery transposition group (n = 100) and vein transplantation group (n = 100). The digital artery transposition technique was used in the artery transposition group, and the autologous vein bridging technique was used in the vein transplantation group. The clinical efficacy and survival rate of severed fingers were compared between the two groups. **Results**: The clinical excellent and good rate in artery transposition group was significantly higher than that in vein transplantation group ($P < 0.05$). **Conclusion**: The transposition of digital artery is effective and safe in replantation of severed fingers with vascular defects.

Keywords: Digital Artery Transposition, Finger Replantation, Joint Function, Neurological Function, Vessel Defect

Introduction

A completely or partially severed finger, resulting from injuries such as chainsaw accidents, twist injuries, crushes, and other causes, is a common injury with important consequences. In these incidents, the amputation of blood vessels, nerves, tendons, bones, joints, and other structures is involved, categorizing them as severe hand injuries[1].

Replantation of severed fingers is a crucial clinical treatment, with the reconstruction of arteriovenous circulation in replanted fingers forming the basis for the survival and functional recovery of severed fingers[2,3]. Both digital artery transposition and vein transplantation are techniques employed to reconstruct finger artery defects. These methods are suitable for patients with severed finger tendons, mild bone fractures, and severe damage to the blood vessels within the residual finger stump. Replantation can be accomplished without shortening or with minimal shortening of the finger bone, preserving the functional length of the finger body as much as possible. However, each technique has its own set of advantages and disadvantages[2,3]. While vein transplantation is rich in materials and mature in technology, it exhibits poor elasticity and has a thin wall, making it prone to thrombosis and spasm after the operation. Digital artery transposition, on the other hand, utilizes proper arteries from adjacent or the same fingers, offering the advantages of similar diameter and good hemodynamics post-transposition. Building on this, our study employs digital artery transposition within the same finger to treat severed fingers with vessel defects. We compare this technique with vein transplantation to explore its therapeutic effects and its impact on the recovery of nerve function and joint function

The authors have no conflict of interest.

Corresponding author: Chunlai Xiao, Department of Hand and Foot Surgery, Hengshui People's Hospital, No.180 Renmin Dong Road, Taocheng District, Hengshui 053000, China
E-mail: xcldu3@126.com

Edited by: G. Lyritis
Accepted 5 December 2023

Table 1. Comparison of basic characteristics of replantation of severed fingers between the two groups.

Group	Number of cases	Gender (male/female, cases)	Age (years old, $\bar{x}\pm s$)	Causes of injury (chainsaw injury/ crush injury/ avulsion injury, case)	Injury site (thumb/ indicator finger/ middle finger/ ring finger/little finger, case)	Injury plane (metacarpophalangeal joint/proximal phalanx/ middle phalanx/distal interphalangeal joint, case)	Time of injury (h, $\bar{x}\pm s$)
Arterial transference group	100	61/39	33.85±8.96	24/29/47	12/31/24/30/3	15/25/28/24/8	2.93±0.96
Vein transplantation group	100	58/42	35.06±9.87	29/26/45	14/33/22/29/2	13/24/30/26/7	3.08±1.03
Statistical value		χ^2=0.187	*t*=0.908	χ^2=0.679	-	χ^2=0.379	*t*=1.065
P value		0.666	0.365	0.712	0.894	0.984	0.288

Note: -indicates that Fisher exact probability method is adopted.

Materials and Methods

Subjects

Patients who underwent replantation of severed fingers at Hengshui People's Hospital from July 2017 to July 2020 were selected as the research subjects. Data from the medical records of 522 patients at our hospital was retrospectively extracted. Inclusion criteria: (1) Age 18 to 60 years old; (2) Completely severed patients with a digital artery defect and different injury planes of bilateral digital arteries; (3) Single severed finger; (4) Phalangeal defect < 1 cm; (5) Those seeking medical treatment within 8 hours after injury; (6) The adjacent fingers had no history of trauma, and the arterial blood supply was normal; (7) Informed consent to participate in the research, and a high degree of cooperation. Exclusion criteria: (1) Those with other serious trauma, compound injury, and multiple organ failure that may affect treatment; (2) Those with serious underlying diseases, such as diabetes that is difficult to control; (3) Pregnant and lactating women; (4) Those who can't tolerate surgery; (5) Lost follow-up or incomplete follow-up data. After applying the exclusion and inclusion criteria, A total of 200 patients were randomly divided into the digital artery transposition group and vein transplantation group, with 100 cases in each group. There was no significant difference in basic characteristics between the two groups (P > 0.05, Table 1). Both study groups exhibited homogeneity, with no statistically significant differences observed in their basic characteristics, affirming their comparability.

Methods

Arterial Transference Group: Debridement of the injured finger was performed under a microscope, involving the removal of severely injured broken bones, subcutaneous tissues, tendons, blood vessels, digital nerves, etc. Simultaneously, stump reduction was performed to clarify the extent of blood vessel and proximal and distal nerve injuries. The phalanx was fixed using Kirschner wire, and subsequent reconstruction included the repair of bone, tendon, nerve, and blood vessel. The positioning of the severed finger was determined based on the length of the tendon, and an incision was made at the proximal end. If the severed finger could be anastomosed with the original muscle tissue, it was replanted in situ; otherwise, it was sutured to the adjacent tendinous tissue. The goal was to suture as many veins as possible. In cases of a severe venous defect in the back of the finger, the surrounding venules were sutured to ensure the smooth anastomosis of two smaller veins or one thicker vein. During arterial reconstruction, the severed arteries of the same finger were meticulously dissected and repaired to normal vascular tissue under a microscope. If the digital arteries on both sides of the injured finger had defects or could not be directly anastomosed on the same plane, the digital arteries on the distal plane of the same finger were anastomosed with the digital arteries on the near plane of the injury. When dissecting the proper arteries, attention was given to protecting the digital nerves, anastomosing the proximal end of the same digital artery with the distal end of the severed finger, and using 10-0 non-invasive sutures. During suturing, both ends of the blood vessels were fully exposed. Longitudinal anastomosis was performed as far as possible without crossing with longitudinal tissues such as tendons. Suturing of blood vessels was done without tension to improve the quality of blood vessel anastomosis. If the severed finger was accompanied by a skin defect, an appropriate skin flap could be selected based on the location and scope of the defect for wound repair. For instance, an adjacent finger skin flap was chosen for wound repair and coverage. Alternatively, a free skin flap was selected for a skin defect on the back of the hand, covering the wound and facilitating the reconstruction of the vein on the back of the hand, which was beneficial for blood reflux.

Vein Transplantation Group: Debridement of the injured finger was performed under a microscope, and the length of arterial defects at both ends was determined. Subsequently, bones, tendons, nerves, and blood vessels were reconstructed sequentially. Superficial veins on the carpometacarpal side of the injured finger were selected for transplantation. Single, H-type, or Y-type veins were chosen based on specific conditions, within a range of 1 to 3 cm. After incising the veins, they were marked upside down and washed with heparin saline for later use. During vascular anastomosis, the length of the vein to be grafted was adjusted to ensure a slight tension. If the vein was slightly lengthy, it could be fixed on the lateral tissue, and the proximal end of the artery could be sleeved with the distal end anastomosed end-to-end.

Postoperative treatment: Both groups received identical care. Smoking and alcohol consumption were prohibited, and routine analgesia, anti-spasm, anticoagulation, and anti-infection treatments were administered. The affected limb was bandaged, elevated to facilitate blood circulation, and subjected to specific electromagnetic wave therapy. Close attention was paid to the blood supply of the affected limb and the presence of arteriovenous crises. After 4 weeks of plaster fixation, the plaster was removed, and functional exercises were initiated under the guidance of medical staff based on the specific recovery situation. Tendon release occurred three months post-operation.

Observation indicators

Perioperative indexes: This includes operation time, survival rate of severed fingers, and the incidence of vascular crises.

Follow-up indexes: A follow-up for 12 months after the operation was conducted to evaluate each index. (1) Neurological function: Refers to abdominal two-point discrimination, and sensory function was evaluated according to the British Medical Research Council (BMRC)[4]. The scale is defined as follows:

- **S0**: No sensation in neural jurisdiction.
- **S1**: Restoration of deep skin pain.
- **S2**: Partial restoration of shallow sensation and touch.
- **S3**: Complete restoration of shallow sensation and touch without allergy.
- **S3+**: Two-point discrimination in addition to S3.
- **S4**: Normal sensation with two-point discrimination < 6 mm.

(2) Joint function: Total Active Motion (TAM) was employed to assess the Range of Motion (ROM) of finger joints, which included the metacarpophalangeal joint (MP), proximal interphalangeal joint (PIP), and distal interphalangeal joint (DIP). Additionally, the evaluation of Activities of Daily Living (ADL) was conducted using the Upper Extremity Function Test (UEFT), consisting of 33 items. Each item was scored on a scale of 0 to 3 points, resulting in a total score ranging from 0 to 99 points. The higher the score, the better the recovery of hand function.

(3) Blood Circulation State and Appearance Recovery: The blood circulation state is classified as follows:

- Better: Normal skin temperature and color without protection, or low skin temperature, poor color, and fear of cold.
- Worse: Cyanotic or pale skin temperature and fear of cold, or cyanotic or gray skin and fear of exposure.

Appearance recovery is evaluated based on the following criteria:

- Better: Replanted finger with no rotation and full angular deformity, shortened < 1 cm without affecting function, or replanted finger with slight rotation, slight angular deformity, slight atrophy, shortened < 1.5 cm without affecting function.
- Worse: Replanted finger with atrophy and shortened < 2 cm, or obvious deformity, shortened ≥ 2 cm, significantly affecting both appearance and function.

(4) Patients' Conscious Satisfaction: The Visual Analogue Scale (VAS) was employed to assess patients' perceived satisfaction, dividing it into 11 levels: 0 to 10 points. Patients selected their satisfaction level on the scale based on their own feelings, with scores of ≥ 8 points indicating satisfaction, 4 to 7 points indicating basic satisfaction, and ≤ 3 points indicating dissatisfaction. The total satisfaction rate was calculated by summing the cases categorized as satisfactory and basically satisfactory.

Evaluation of Treatment Efficacy: The assessment of the replantation function of severed fingers adhered to the evaluation standards outlined by the Society of Hand Surgery of the Chinese Medical Association. The comprehensive evaluation categorized the recovery into the following ranges: excellent (80 to 100 points), good (60 to 79 points), poor (40 to 59 points), and inferior (below 40 points). The clinical excellent and good rate was determined by summing the cases classified as excellent and good.

Statistical analysis

Data analysis was performed using SPSS 22.0 statistical software. Descriptive statistics for measurement data were expressed as $\bar{X} \pm s$, and comparisons between the two groups were conducted using an independent sample t-test. The number of cases (%) for categorical data was compared using the χ^2 test or Fisher's exact probability method. Grade data comparisons were performed using the Z-test. A p-value < 0.05 was considered statistically significant.

Results

Comparison of clinical efficacy between patients in the two groups

The clinical excellent and good rate among patients with arterial transposition was higher than that among patients with vein transplantation (P < 0.05, Table 2).

Table 2. Comparison of clinical efficacy of replantation of severed fingers between two groups [case (%)].

Group	Cases	Excellent	Good	Poor	Inferior	Clinical excellent and good rate
Arterial transference group	100	62 (62.00)	29 (29.00)	6 (6.00)	3 (3.00)	91 (91.00)
Vein transplantation group	100	50 (50.00)	31 (31.00)	14 (14.00)	5 (5.00)	81 (81.00)
Z value						4.153
P value						0.042

Table 3. Comparison of perioperative indexes of replantation of severed fingers between two groups.

Group	Cases	Operation time (min, $\bar{x}\pm s$)	Survival of severed finger [cases (%)]	Vascular crisis [Cases (%)]
Arterial transference group	100	45.38±9.47	95 (95.00)	19 (19.00)
Vein transplantation group	100	58.67±10.25	87 (87.00)	24 (24.00)
Statistical value		t=9.523	χ^2=3.907	χ^2=0.741
P value		0.001	0.048	0.389

Table 4. Comparison of neural function recovery after replantation of severed fingers between two groups.

Group	Cases	Two-point discrimination of finger abdomen (mm, $\bar{x}\pm s$)	Sensory recovery ($S_2/S_3/S_{3+}/S_4$,cases)
Arterial transference group	100	4.35±0.77	7/12/48/33
Vein transplantation group	100	5.96±0.83	19/19/33/19
Statistical value		t=14.221	Z=11.163
P value		0.001	0.011

Comparison of perioperative indexes between patients in the two groups

In comparison with the vein transplantation group, the transposition group exhibited a shorter operation time and a higher survival rate of severed fingers (P < 0.05). No significant difference was observed in the incidence of vascular crises between the two groups (P > 0.05, Table 3).

Recovery of nerve function after replantation of severed fingers in patients in the two groups

In comparison with the vein transplantation group, patients with arterial transposition exhibited shorter discrimination and superior recovery of sensory function (P < 0.05, Table 4).

Recovery of joint function after replantation of severed fingers in two groups

The mobility of the metacarpophalangeal joint (MP), proximal interphalangeal joint (PIP), distal interphalangeal joint (DIP), and scores for daily living activities in the arterial transposition group were significantly higher than those in the vein transplantation group (P < 0.05, Table 5).

Blood circulation status and appearance recovery after replantation of severed fingers in two groups

Following the replantation of severed fingers, patients with arterial transposition exhibited significantly better blood circulation status and appearance recovery compared to those with vein transplantation (P < 0.05, Table 6).

Table 5. Comparison of joint function recovery after replantation of severed fingers between two groups (s).

Groups	Cases	Finger ROM (°)			UEFT (score)
		MP	PIP	DIP	
Arterial transference group	100	74.33±11.45	62.38±9.42	35.61±10.85	91.33±5.04
Vein transplantation group	100	65.89±9.76	59.47±10.56	32.11±8.97	89.42±4.76
t value		5.609	2.056	3.196	2.755
P value		0.001	0.041	0.002	0.006

Note: MP is metacarpophalangeal joint; PIP is proximal knuckle; DIP is distal knuckle; UEFT is Carroll's hand function evaluation method.

Table 6. Blood circulation status and appearance recovery after replantation of severed fingers in the vein transplantation group (cases).

Groups	Cases	Blood circulation state (excellent/good/poor/bad, Cases)	Appearance (excellent/good/poor/bad, Cases)
Arterial transference group	100	73/19/6/2	61/25/9/5
Vein transplantation group	100	61/23/9/7	48/29/10/13
Z value		3.913	4.316
P value		0.048	0.038

Table 7. Comparison of self-satisfaction of replantation of severed fingers between two groups [case (%)].

Group	Number of cases	Satisfied	Basic satisfaction	Dissatisfied	Total satisfaction rate
Arterial transference group	100	72 (72.00)	24 (24.00)	4 (4.00)	96 (96.00)
Vein transplantation group	100	55 (55.00)	32 (32.00)	13 (13.00)	87 (87.00)
Z value					5.207
P value					0.022

Comparison of conscious satisfaction between the two groups

The total satisfaction rate among patients with arterial transposition was significantly higher than that in the vein transplantation group ($P < 0.05$, Table 7).

Discussion

Replantation of severed fingers stands as the primary treatment for such injuries, with the key to its success lying in the reconstruction of the vascular structure. Historically, the treatment of complex severed fingers often involved shortening the phalanx. However, this approach can adversely affect the function and appearance of the affected fingers. Shortening the phalanx by ≥ 2.5 cm during the replantation of severed fingers is considered to diminish the significance of the procedure[5]. Therefore, it becomes imperative to maximize the survival rate without shortening the phalanges, aiming to enhance the function and appearance of the affected fingers to the greatest extent possible

Vein transplantation serves as an effective means to alleviate the 'tension' in blood vessel length during the replantation of severed fingers. It facilitates the reconstruction of arterial blood flow while preserving the length of affected fingers. Existing literature underscores the abundance of veins on the volar side of the forearm, offering a variety of diameters and types for transplantation. The procedure is convenient to perform, and posterior venous excision effects on limbs are generally insignificant[5-7]. Nonetheless, it's important to note that vein transplantation also has its limitations. Firstly, the length of the transplanted vein is restricted, typically not exceeding 5 cm. Longer segments pose an increased risk of thrombosis. Additionally, venous vessels, characterized by varying diameters and thin walls, are prone to spasm after transplantation, heightening the risk of vascular crises. In contrast, the use of finger artery transplantation effectively mitigates these drawbacks. This technique leverages local materials, selecting the appropriate artery from the same finger or a healthy adjacent finger as the blood vessel donor.

The incision vessels is longer, of higher quality, and exhibits a diameter similar to that of the severed finger. These factors collectively provide robust assurance for optimal blood supply following the replantation of severed fingers[5,6]. In this study, digital artery transposition was employed, involving the anastomosis of the distal end of the proximal digital artery with the proximal end of the severed one. This approach not only effectively reconstructs arterial blood supply and venous return but also circumvents damage to adjacent fingers and preserves the blood supply to healthy fingers, all without introducing trauma to other areas. Furthermore, digital artery transposition results in only one anastomotic stoma, reducing the risk of adverse reactions like anastomotic spasm and embolism, thereby enhancing the survival rate of severed fingers. For the operator, utilizing digital artery transposition from the same finger significantly reduces the steps required under the microscope and shortens the overall operation time.

The findings of this study reveal that the clinical excellent and good rates, as well as patient satisfaction, in the transposition group, are significantly higher compared to those in the vein transplantation group. Moreover, the transposition group exhibits a shorter operation time and a higher survival rate of severed fingers. Although there is no statistically significant difference in the incidence of vascular crises between the two groups, the results indicate that, when compared with the vein transplantation method, digital artery transposition from the same finger effectively enhances the survival rate and overall success of replantation in cases of severed fingers with vessel defects. Additionally, it leads to shorter operation times without increasing the risk of vascular crises, resulting in higher patient satisfaction, which echos the results of prior research[8-10]. In general, the primary objective of replantation for severed fingers is to ensure their survival within a 2-week timeframe. The ultimate goal, following successful survival, is to restore the nerve and joint functions of the affected fingers as comprehensively as possible. The results of this study demonstrated that, when compared to the vein transplantation group, patients in the arterial transference group exhibited shorter finger-pulp discrimination, improved sensory function recovery, and significantly enhanced finger joint range of motion, along with higher scores for activities of daily living.

These outcomes suggest that the same finger arterial transference technology contributes more significantly to the improvement of neurological and joint functions after replantation of severed fingers compared to vein transplantation technology. This observation can be attributed to the advantages inherent in the same finger arterial transference technology. In comparison with other arterial transference methods, digital artery transposition from the same finger eliminates the need to sacrifice another digital artery, thereby avoiding unnecessary trauma to other areas. This ensures a stable and reliable venous return for replanted fingers, providing sufficient blood oxygen supply, promoting wound healing, and reducing the frequency of wound treatment interventions such as infection management, dressing changes, and finger bloodletting. Consequently, this approach minimizes tissue damage following the replantation of severed fingers, establishing favorable conditions for the recovery of nerve and joint functions in the affected fingers. Moreover, the higher diameter and better elasticity of the two digital arteries in the same finger enhance blood reflux, effectively mitigating the risk of finger swelling.

This proactive measure helps prevent swelling-induced compression of blood vessels, safeguarding local tissue and nerve blood oxygen supply. The digital artery transposition from the same finger not only streamlines the microscopic operation but also reduces the overall operation time. Moreover, this study observed that the blood circulation state and appearance recovery of severed fingers following replantation in the arterial transference group were significantly superior to those in the vein transplantation group. This finding suggests that the technique of transposing the same finger artery positively influences the blood circulation state and appearance recovery after the replantation of severed fingers[11]. Such benefits may be attributed to the superior quality of arterial blood vessels and the more stable arterial blood supply associated with this approach. While arterial transplantation shows promise in improving neurological and joint functions after finger replantation, it is important to acknowledge that venous transplantation still holds significance in certain circumstances[12-14]. Venous transplantation ensures adequate blood outflow, preventing venous congestion and potential complications such as edema[15-17]. In complex finger replantation cases, a combination of arterial and venous transplantation techniques may be necessary to ensure successful restoration.

In conclusion, digital artery transposition, when compared to traditional vein transplantation, proves to be effective in reducing the operation time for replantation of severed fingers with vessel defects. This technique demonstrates improvements in the survival rate, as well as the clinical excellent and good rate of severed fingers. Consequently, it contributes positively to the recovery of neurological function, joint function, and appearance in patients post-operation, with a favorable safety profile.

Ethics approval

This study was approved by the Medical Ethics Committee of Hengshui People's Hospital.under the approval ID of HP20220345

Funding

This work was supported by Scientific Research Fund Project of Hebei Provincial Health and Health Commission (20181573).

Authors' contributions

CX designed the study and drafted the manuscript. GB and GZ were responsible for the collection and analysis of the experimental data. YG, QW and HL revised the manuscript critically for important intellectual content. All authors read and approved the final manuscript.

References

1. Corry RJ, Russell PS. Replantation of severed fingers. Ann Surg 1974;179(3):255-259.
2. Gürbüz K, Yontar Y. A four-year community hospital experience regarding procedures for the replantation and revascularization of fingers. Jt Dis Relat Surg 2021; 32(2):383-390.
3. Li B, Xiao L, Ye D, Zhong S, Yan Q. The expression of NOTUM in replantation of severed fingers may be an important treatment factor. Ann Hum Genet 2023; 87(1-2):18-27.
4. Lebowitz MD, Burrows B. Comparison of questionnaires: the BMRC and NHLI respiratory questionnaires and a new self-completion questionnaire. Am Rev Respir Dis 1976;113(5):627-635.
5. Lin YT, Loh CYY. Application of Concatenated Arterialized Venous Flaps in Finger Reconstruction. Ann Plast Surg 2019;82(3):292-295.
6. Yan H, Gao W, Zhang F, Li Z, Chen X, Fan C. A comparative study of finger pulp reconstruction using arterialised venous sensate flap and insensate flap from forearm. J Plast Reconstr Aesthet Surg 2012;65(9):1220-1226.
7. Zhao J, Abdullah S, Li WJ, Appukuttan A, Tien HY. A novel solution for venous congestion following digital replantation: a proximally based cross-finger flap. J Hand Surg Am 2011;36(7):1224-1230.
8. Ju H, Li L, Wang X, Mu J, Ge L, Wu S. Practical study on the application of full-cycle fast track surgical nursing model in patients with replantation of severed fingers: A retrospective analysis. Medicine (Baltimore) 2023;102(42):e35665
9. Wang N, Xiao H, Lu H, Chen K, Zhang S, Liu F, Zhang N, Zhang H, Chen S, Xu X. Effect of PI3K/AKT/mTOR signaling pathway-based clustered nursing care combined with papaverine injection on vascular inflammation and vascular crisis after replantation of severed fingers. Mol Cell Biochem 2023.
10. Hoffa MT, Benedick A, Simske JS, Vallier HA. Upper Extremity Wood Saw Injuries: Experience at a Single Level 1 Trauma Center. Hand (N Y) 2023; 24:15589447231174044.
11. Li B, Xiao L, Ye D, Zhong S, Yan Q. The expression of NOTUM in replantation of severed fingers may be an important treatment factor. Ann Hum Genet 2023;87(1-2):18-27.
12. Zyluk A. Ten-Year (2010-2019) Activity Report of the Replantation Service for Hand and Finger Amputations in Poland. Handchir Mikrochir Plast Chir 2023;55(1):41-46.
13. Deeg S, Boettcher M, Svoboda D. Case Report: 2-Year-Old Boy with Grade 4 Avulsion Injury of the Hand Caused by a Conveyor Belt System. Klin Padiatr 2023;235(1):45-47.
14. Cui Y, Wang J, Lin J, Pei Y, Zhu L, Xu Q. Long-term outcomes of toe replantation: A review of ten cases. J Plast Reconstr Aesthet Surg 2022;75(11):4042-4047.
15. Chen G, Wang W, Wang P, Zhang N, Xiu X, Zhao J. Clinical Application of Restrictive Brace Combined with Psychological Intervention after Replantation of Severed Fingers in Children. Comput Math Methods Med 2022;2022:9631858.
16. Xu T, Chen X, Li X, Wang M, Wang M. Analysis of Anesthesia Effect of Dexmedetomidine in Clinical Operation of Replantation of Severed Finger. Comput Math Methods Med 2021;382245.
17. Delvaque JG, Mas V, Simon AL, Ilharreborde B, Jehanno P. Results of central ray metacarpal resection after failure of digit replantation in children. Hand Surg Rehabil 2021;40(5):670-674.