

Three-year (2014–2016) activity report of the Replantation Service for amputated hands in Poland

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ABSTRACT:

The paper summarizes 32 months (January 2014 – August 2016) of activity of the Replantation Service for hand amputation in Poland. Over this period a total of 568 cases of total and subtotal amputations as well as other complex injuries to the hand were referred. Of these, 354 referrals (62%) were accepted and 214 (38%) rejected. Among accepted, there were 167 total (47%) and 142 subtotal (40%) amputations; 45 patients (13%) had other severe hand injuries. Vast majority of the patients constituted males aged a mean of 39 years. The most common injury was amputation of several digits in one patient, and thumb amputation – a total of 229 cases (65%), followed by transmetacarpal and wrist amputations – 92 (30%) and forearm/arm amputations – 33 cases (9%). Replantation of amputated extremity was performed in 141 patients (40%), revascularization in 145 (41%) and in 29 (8%) primary repair of the complex injuries. In 27 cases (8%), a coverage of the tissue defects, and in 12 (3%) primary terminalization was performed. Survival rate was of 78% for replantation and revascularization. Comparing to the period 2010–2012, an increase in number of treated patients (of $n = 64$ cases), in number of amputations (of 96 cases) and in number of amputated digits (of 88 cases) were noted. The activity report shows importance of Replantation Service, an informal structure, in saving limbs of severely mutilated patients.

KEYWORDS:

hand replantation, microsurgery, outcome measurement

INTRODUCTION

In 2010, due the initiative of the Polish Society for Surgery of the Hand, the so-called Replantation Service (abbreviated as Service), defined as „readiness to provide advice and help in cases of some upper limb amputations”, was found. In the first two years of operation, the Service consisted of three centers: in Trzebnica, Poznań and Szczecin. In the following years, four more centers joined: Kraków, Gdańsk, Elbląg and Wrocław; therefore currently, seven branches are involved in this activity. Four of them are traumatic-orthopedic wards (Poznań, Gdańsk, Wrocław and Elbląg), two are general surgery wards (Trzebnica and Szczecin) and one is a plastic surgery ward (Kraków). Every day, a different unit remains in the state of readiness, admitting reports of hand amputation (from metacarpal level), thumb amputation and several-digit amputation from all over the country. The scope of service also includes certain cases of crushing and scalping of the hands, which require a microsurgical facility, or coverage of cavities with flaps.

Organization of the Service is as follows [1]:

- Contact of a physician reporting a case of amputation with a doctor on duty takes place directly or via the Air Rescue Service that is informed about the department on call.
- It is required that the case be reported by a specialist doctor, surgeon or orthopedist. Reports from AMU physicians, residents or paramedics are not accepted. This results from the necessity of experience in real assessment of the cut-off limb and patient's condition, i.e., assessment whether the limb is suitable for replantation and if the patient is fit for transportation.
- It is required to send by MMS message a photograph of the

cut-off limb and stump as well as X-rays in case of crushing (Fig. 1, 2).

- Interview with a competent physician from the center and analysis of received photographs constitute the basis for making a decision on acceptance or refusal of the application.
- In the first case, the unit managing the patient organizes transport, most often by air. Even if the claimant accepts the notification, it is necessary to calculate the time of transport.

In 2014, there was a report published on the first 2.5 years of the Replantation Service [2]. The purpose of the present work is to summarize the activities of centers in the period 01.2014 - 08.2016.

MATERIAL AND METHODS

Data for this work was obtained from surveys sent to each of the centers participating in activity of the Service. Data from 5 units were collected, as the branch in Elbląg did not send back the questionnaire, and the branch in Wrocław began operations from mid-2016. The obtained data was compiled and presented in the form of tables I-VII.

RESULTS

Data was collected for the period of almost 3 years (32 months) of the Replantation Service's activity, from January 2014 to August 2016. In the analyzed period, a total of 558 cases of amputations, subtotal amputations, or other extensive upper limb-threatening injuries were reported to 5 branches participating in the Service.

Tab. I. Activity of the Replantation Service over the period January 2014 - August 2016.

PARAMETER	GDAŃSK	KRAKÓW	POZNAŃ	TRZEBNICA	SZCZECIN	TOTAL
Number of notifications	41	154	110	96	167	568
Number of admissions	13 (32%)	122 (79%)	66 (60%)	60 (62%)	93 (56%)	354 (62%)
Number of refusals	30 (68%)	32 (21%)	44 (40%)	36 (38%)	74 (44%)	214 (38%)
Gender M/F	12/1	106/16	64/2	51/9	85/8	318/36
Age in years (mean, range)	34	40	38 (2-69)	41	40 (8-82)	39 (2-82)
Limb R/L	-	54/68 44%/56%	32/34 48%/52%	43/17 72%/28%	52/41 56%/44%	181/160 51%/49%

Tab. II. Characteristics of injuries admitted.

STRUCTURE OF INJURIES	GDAŃSK	KRAKÓW	POZNAŃ	TRZEBNICA	SZCZECIN	TOTAL
Total amputation	10	60	29	16	52	167
Subtotal amputation	3	56	33	28	22	142
Crushing	-	6	4	4	8	22
Large wound	-	-	-	12	11	23
Total	13	122	66	60	93	354

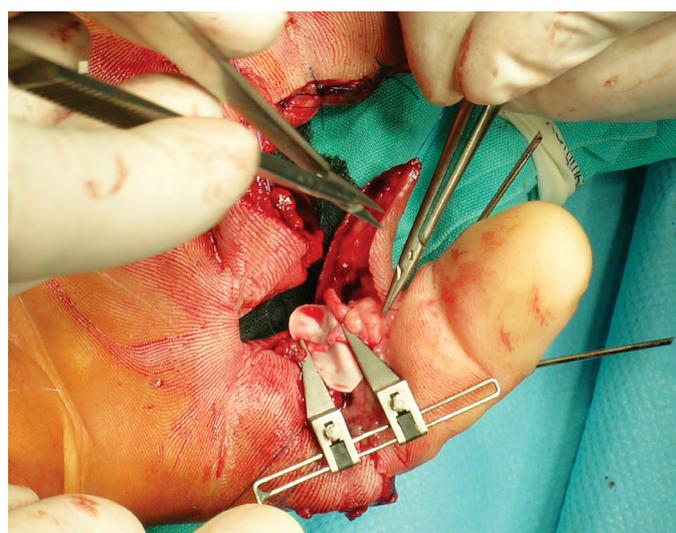
Of these, 354 applications were accepted (62%) and 214 (38%) were refused. Table I presents these data broken down into individual branches operating in the Service. Predominantly (90%), amputations were experienced by young and middle-aged men. In 21 cases (6%), amputation concerned children, of which the youngest was 2 years old. There was also a patient at the age of 82 who was operated, in whom 2 out of 4 amputated digits were replanted in the Szczecin clinic (Fig. 4 a-c). This is the oldest patient in Poland and one of several 80-year-olds in the world who has managed to have an amputated limb sewn back successfully.

The structure of injuries is presented in Table II. Of the 354 cases admitted, there were 167 total amputations (47%), 142 (40%) subtotal amputations and 45 (13%) other serious limb-threatening injuries, such as crushing, scalping and extensive lacerations.

Most often, amputation or extensive trauma were caused by a circular saw - 175 cases (49%) and an industrial or agricultural machine - 126 (36%) (Table III).

The level of amputation is illustrated in Table IV. Most were digital amputations - including the thumb - 229 cases (65%). It should be noted that the term „digital amputation” meant amputation of several fingers (at least three) in one person, not individual long fingers. Single-digit amputations do not fall within the scope of the Service, as these injuries are so frequent that replanting centers are unable to accept them due to logistical reasons. However, this does not apply to thumb amputation, of which there were 112 cases (32%). In 134 cases (38%) injuries concerned the level from the metacarpus to the arm, of which most were amputations of the metacarpus - 51 cases (14%) and wrist - 41 (11%).

Table V shows the number of individual operations performed in patients admitted to the Service. In 141 patients (40%) a completely amputated limb was sewn on, fingers or thumb (replantation), in 145 (41%) amputated almost totally, holding on a piece of skin,

**Fig. 1.** Digital artery anastomosis in digital replantation.

muscle or tendon but without vascularity (revascularization), and in 29 (80 %) repair of extensive, multi-tissue lesions in the limb, which was not completely ischemic (primary reconstruction). In 27 cases (7%) of scaling or crushing followed by necrosis of soft tissues, coverage of defect with pedicle flap was made. In 12 patients (3%), no attempts were made to replant, only a digit/limb stump was provided, most often due to significant damage to the amputate.

It is obvious that in cases of amputation and other extensive limb injuries, despite performance of surgery, it is not always possible to keep the limb. Table VI shows the effectiveness of treatment in individual centers. The number of cases in the first row does not match the number from the previous tables, as it is reduced due to terminalizations (supply of the stump only) when no attempt to replant has been made. Effectiveness of replantation and revascularization at a level of 80% is a good result, given the unfavorable mechanism of injury (crush, avulsive) in some cases, long transport time, causing surgery to sometimes begin after 8 hours of injury, and furthermore given the „positive” approaches of the Service’s participants, who also accept difficult cases, with dubious chances of successful replantation.

Cases of digital and limb amputations and the results following replantations performed in the Szczecin center are illustrated in Fig. 1-7.

DISCUSSION

In our previous report that also covers a period of 32 months

Tab. III. Tools causing amputation/injury.

WOUNDING TOOL	GDAŃSK	KRAKÓW	POZNAŃ	TRZEBNICA	SZCZECIN	TOTAL
Circular saw	3	75	25	26	46	175
Industrial machine	7	41	22	22	34	126
Axe	3	6	5	9	6	29
Other	-	-	14	3	7	24
Total	13	122	66	60	93	354

(01.2010 - 08.2012), we presented data from the first period of the Service [2]. Comparison of data from these two time intervals is presented in Table VII. In the reported period, there were 21% more admissions (64 people) and more cases of amputations (96 cases). In the previous one, there were more extensive wounds and crush injuries. The structure of injuries is also different: in the period currently reported, there were many more cases of amputation of several digits and thumbs, a comparable number of amputations at metacarpal and wrist level, and less proximal amputations (forearm and upper arm). The survival rate of replanted limbs was also lower by 11%. This phenomenon may result from several reasons:

- A much larger number of amputated digits. Finger replantation is a more demanding procedure and risk of failure is greater than, for example, in case of wrist replantation.
- A much larger number of total amputations in which the prognosis is worse than in subtotal amputations, due to frequent venous outflow disorders.
- Acceptance of cases with doubtful chances of replantation success (crushing injury, with a significant damage to the amputate).

Table I shows that most amputations are directed to centers in Krakow and Szczecin, and the least to Gdańsk and Elbląg. There are no exact data from the Elbląg center, but information obtained from a colleague who runs this department shows that the number of cases treated there is similar to that in the Gdansk clinic. A significantly higher number of amputations treated in Krakow and Szczecin results from the fact that both centers accept patients and amputations from their province and one neighboring province, as well (respectively: Małopolskie and Podkarpackie provinces, as well as Zachodniopomorskie and Lubuskie), regardless of being „in readiness” or not. Both centers have a sufficient number of surgeons and access to operating theaters, which allows to provide permanent service for local needs. Other units do not have such human resources or logistics. In turn, a relatively small number of patients treated in Gdańsk results from the fact that this center had just started its activity in 2014. Currently, the number of replantations performed there is higher and close to the „service” average.

EPIDEMIOLOGY OF UPPER LIMB AMPUTATION

The frequency of amputation varies from country to country and is primarily influenced by the safety and organization of work in the industry, services and households. In countries of the „old” European Union and the United States, limb amputations are much rarer than in developing countries [3, 4]. This is

Tab. IV. Level of amputation, excessive wound, crushing or degloving injury.

LEVEL OF AMPUTATION	GDAŃSK	KRAKÓW	POZNAŃ	TRZEBNICA	SZCZECIN	TOTAL
Digits (number of patients)	5	55	22	13	22	117
Thumb	4	40	25	10	33	112
Metacarpus	2	18	9	9	13	51
Wrist	1	4	4	18	14	41
Forearm	1	4	5	8	10	28
Elbow/shoulder	-	1	1	2	1	5
Total	13	122	66	60	93	354

due to the use of more advanced technologies in the industry, elimination of work with dangerous devices, tradition of observing the rules of safe work, but also results from a less widespread use of dangerous devices (mainly circular saws) among the population. In the US, over 3,900 cases of amputations in the upper limb were recorded within 3 years, of which 1,300 patients underwent replantation or revascularization, giving an average of just over 400 such operations per year [5]. In Poland, traumatic amputations in the upper limb are relatively frequent. Data collected during operation of the Replantation Service show that over a period of 5 years, a total of 1,000 cases of amputations, subtotal amputations or other extensive upper limb-threatening injuries were reported. Assuming that about 20% of injuries were not reported for various reasons, this gives an estimated 240 amputations a year, of which about 60% of cases are suitable for surgery.

EFFECTIVENESS OF REPLANTATION

The percentage of effective replantations given in literature ranges from 56% to 93% [3, 6, 7, 8]. Discrepancies result not only from varying microsurgical skills among surgeons (Asians have greater predispositions), but also from the diversity of groups of patients. A significantly higher percentage of failures is recorded in:

- Avulsive and crushing amputations;
- Distal fingertip amputation;
- After a long period of ischemia;
- In elderly people.

Improvement of technique and greater microsurgical experience increase the survival rate. On the other hand, the extension of indications for replantation and attempts to perform them in cases of initially poor prognosis lower this index.



Fig. 2 a, b. Avulsive amputation of the thumb and long-term result following replantation.

Tab. V. Types and numbers of procedures performed.

TYPE OF OPERATION	GDAŃSK	KRAKÓW	POZNAŃ	TRZEBNICA	SZCZECIN	TOTAL
Replantation	10	60	25	16	30	141
Revascularization	3	56	36	28	22	145
Reconstruction	-	-	-	13	16	29
Coverage with graft	-	-	3	2	22	27
Terminalization	-	6	2	1	3	12
Total	13	122	66	60	93	354

Tab. VI. Effectiveness of treatment assessed by survival rate of operated limbs or digits.

TYPE OF OPERATION	GDAŃSK	KRAKÓW	POZNAŃ	TRZEBNICA	SZCZECIN	TOTAL
Replantation	8/10 80%	86/116 74%	54/61 88%	11/16 69%	18/30 60%	222/286 78%
Revascularization	3/3 100%	-	-	25/28 89%	17/22 74%	-
Reconstruction	-	-	-	100%	100%	100%
Coverage with graft	-	-	100%	100%	100%	100%

REPLANTATION VS TERMINALIZATION

If amputation of the whole hand, thumb or several digits is an indication for replantation, then the loss of a single finger is not always. Within the Service, single-digit amputations are not routinely accepted. They are usually performed only in patients from the parent province when there is no need for long and expensive transport. Functional results after single-digit replantation are not predictable. It happens that a sewn-on finger is even more troublesome in everyday activities, as it is stiff, sensitive to cold and has no feeling [9]. In the work of the Szczecin center, results of treatment of 21 patients who underwent amputation of a total of 35 fingers, including 8 thumbs, were evaluated. Eleven patients underwent replantation, or flap-plasty with maintenance of the finger's length, and 10 terminalization (supply of the finger stump). The results were evaluated after approx. 5 years from injury. Patients with stumps had a stronger global grip - 72% of the strength of a healthy hand, compared to the replantation group - 48%. Hand fitness expressed with the quickDASH score (29 vs. 33) and the quality of life assessment expressed with the SF-36 survey (63 vs. 67) were similar in both groups. Following terminalization, patients returned to work much earlier than after replantation or reconstruction (6 vs. 12 mon-

Tab. VII. Comparison of data from two periods of operation of the Replantation Service.

PARAMETER	PERIOD 2010–2012	PERIOD 2014–2016	DIFFERENCE
Number of admissions	290	354	64
Number of total amputations	100	167	67
Number of subtotal amputations	113	142	29
Number of patients with digital amputation	141	229	88
Number of hand and wrist amputations	84	92	8
Number of amputations above wrist	50	33	-17
Survivability after operations	159/178 89%	222/286 78%	-11%

ths) [10]. The obtained results indicate that from the point of view of the hand function, sewing back the amputated finger, or advanced reconstruction is less beneficial for the patient, than a simple stump supply. These observations are an indirect confirmation of the legitimacy of the rule adopted by the Service, refusal for reports of amputations of single long digits.

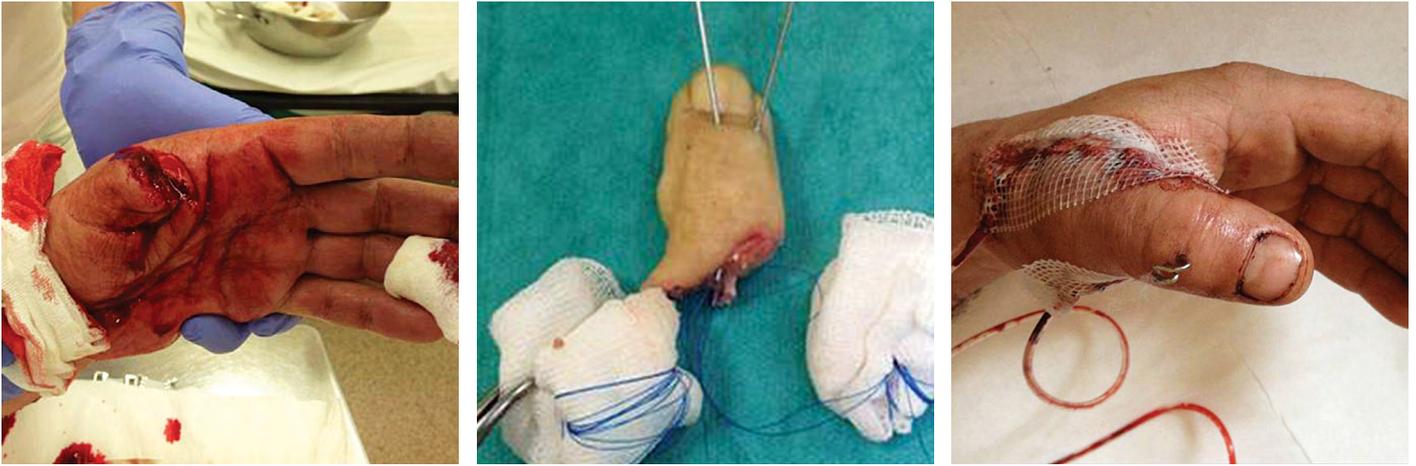


Fig. 3 a, b, c. Amputation of the thumb and image immediately after replantation.



Fig. 4 a, b, c. Amputation of metacarpus and long-term result after replantation of 2 digits.



Fig. 5 a, b. Almost total amputation of the metacarpus and partial amputation of the second-hand digits.

FINAL REMARKS

From the very beginning of the Service, subsequent presidents of the Polish Society for Surgery of the Hand have made attempts to formalize its activity and put it in the organizational framework so as to create a system that works similarly to a transplant service. However, previous talks with officials from the Ministry of Health and the NFH have not led to any agreements, mainly due to the reluctance of decision-makers to separate financing

of these services as highly specialized procedures (such as organ transplants). This means that from the day of its establishment in 2009, the Replantation Service is still a charitable structure, created and run by a group of enthusiasts who save human health spending many hours (usually at night) in the operating room without any remuneration. Talks with other centers that could potentially support this system, having specialists trained in microsurgery usually end with refusal, which is caused by lack of separate financing of this activity and operation under the basic

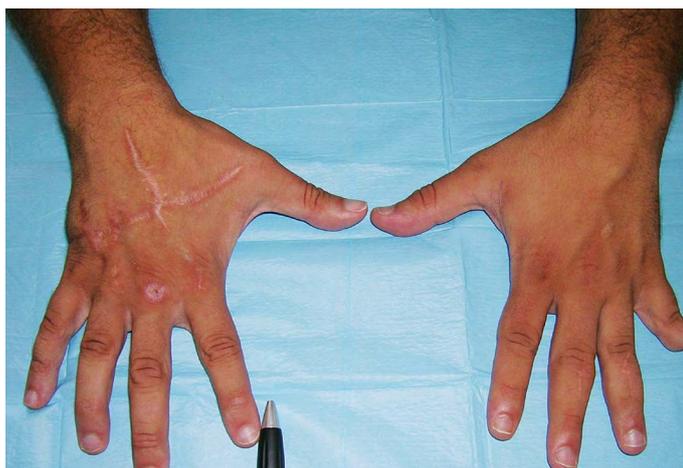


Fig. 5 c, d. Long-term result after metacarpal revascularization.



Fig. 6 a, b, c, d. Oblique amputation of the metacarpus and long-term result after replantation.



Fig. 7 a, b. Excellent long-term result after replantation of amputated forearm. The patient returned to work with the same machine which caused injury.

contract with the National Health Fund, which does not provide payment for performed cross-border benefits. There is an obvious need to create at least two replantation centers in the eastern half of the country. In Warsaw and Białystok, there are centers

that have both staff and logistic possibilities to participate in the Replantation Service. Their creation would significantly shorten the patient's path to the hospital, increase the chances of successful replantation and reduce costs.

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