THREE-YEAR ACTIVITY REPORT OF THE REPLANTATION SERVICE FOR AMPUTATION OF THE HAND IN POLAND

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A permanent on-call service for hand amputation (Replantation Service) was established in 2010 as the initiative of the Council of Polish Society for Surgery of the Hand. It is run by three qualified hand centres in Trzebnica, Poznań and Szczecin.

**The aim of the study** was to present a summary of the almost three-year activity of this service.

**Material and methods.** Over this period, a total of 435 cases of total amputations, subtotal amputations and other severe injuries to the hand were referred. Of these, 290 referrals (67%) were accepted and 141 (33%) rejected. Among accepted, there were 100 total (34%) and 113 subtotal (39%) amputations; 81 patients had other, severe hand injuries, such as crush, degloving and extensive wounds involving all tissues.

**Results.** Young and middle-age males constituted the majority of patients with the mean age of 42 years (range 2-82). The most common injury was amputation of several digits (including thumbs) in one patient – 141 cases (48%), followed by amputations from the metacarpal- to the proximal forearm level – 115 (39%) and elbow/arm level – 9 cases (3%). Nineteen patients (6%) had multi-level amputation or injury of the involved extremity. Replantation of the completely amputated extremity was performed in 83 patients (28%), revascularization in 95 (32%) and in 59 (20%) primary repair of the complex injuries. In 23 cases, the repair of tissue defects was performed with flaps, mostly with greater omentum. Survival rate was of 84% for replantations and 88% for revascularizations.

**Conclusion.** Establishing of the Replantation Service constituted a significant progress in organization of the management of the most severest upper limb injuries.

**Key words:** hand replantation, microsurgery, outcome measurement

In 2010, the Council of the Polish Society for Surgery of the Hand established the Replantation Service, i.e. a permanent on-call service for hand amputation provided by three centers in Trzebnica, Poznan, and Szczecin. Each day one of the centers is on call, and receives the reports of hand amputations from and below the metacarpal level, thumb and several finger amputations. The scope of the service also includes selected cases of crush and degloving injuries requiring microsurgical intervention or flap repairs.

Organization of the Service:
– The referring doctor reports the case of hand amputation either directly to the doctor on-call at the respective hand trauma center, or to the air emergency medical service, which dispatches the report further.
– Only specialists of surgery or orthopedics are allowed to report the amputation cases because it is assumed that doctors of Emergency Departments, residents, and paramedics lack the necessary experience to evaluate both the patients’ general condi-
tion as well as the injury to the limb, and thus the actual chances of replantation and safe medical transport.

- It is required to mail by a mms telephone service a picture of the amputated limb, the stump and an X-ray of the affected limb in case of mutilation (fig. 1, 2).
- A decision about the acceptance or rejection of the submission is based on the direct report of the competent doctor representing the referring unit and the analysis of the received pictures.
- In the first option (acceptance), the referring unit organizes the transportation, mostly by air emergency medical service. Even in case of acceptance, a calculation of the perceived duration of the transportation is mandatory.

MATERIAL AND METHODS

The gathered data covered three years of duty (32 months), from Jan 2010 to Aug 2012. Given 10 days on-call a month, each center of the Service completed 320 days on-call. The hand injuries were evaluated using a protocol designed by the Federation of European Societies for Surgery of the Hand (FESSH), which defines each of the terms: a) total amputation; b) subtotal amputation; c) complex, multitissue hand injury; d) replantation; e) revascularization; f) terminalization. Data collection, documentation and filing methods were uniform in all the three centers, hence their results are comparable.

RESULTS

Over the studied period, the Service received submissions of 435 cases of total amputations, subtotal amputations and other severe, complex injuries threatening with the loss of the upper limb (tab. 1). Two-hundred-ninety cases were accepted (67%), while 141 were rejected (33%). In four cases a detailed telephone advice was given on the optimal treatment which did not require microsurgical skills. These 4 cases were monitored on a daily basis by telephone and the Internet.

Fig. 1. Subtotal, crush amputation of the hand caused by (A) a press, (B) a tramway
No replantation possible

Fig. 2. Crush-avulsion amputation of the whole forearm by agriculture machinery. The picture sent by a mms. Admission denied, no replantation possible
Table 1 presents the data separately for each center of the Service. The 290 admittances comprised of 100 total (34%) and 113 subtotal (39%) amputations, and 81 other severe injuries (27%) threatening with the loss of the upper limb, such as crushing, degloving and extensive laceration. The structure of the injuries was presented in Table 2.

Table 2 summarizes the demographic characteristics of the admitted patients. The majority of them were young and middle-aged males, with a small number of children out of whom the youngest, a 2-year-old, suffered a subtotal amputation of the index finger at the proximal interphalangeal joint; the finger was successfully revascularized. The child qualified to the replantation service because he/she was from the same city as the hand trauma center which coincided to be on-call that day.

Table 4 presents the levels of amputations and injuries with respect to the centers attending them. The most common were finger amputations including the thumb – 141 cases (41%). It should be noted, however, that the term „finger amputations” denotes the amputation of at least 3 fingers in one patient, and not the loss of singular fingers (fig. 3), which on account of its commonness cannot be attended to by the Service centers due to logistic reasons. Single finger replantations are performed at the centers as a part of the regular on-call duty for the respective voivodship, hence they have not been included in this re-
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Port. In 115 cases (39%) the injuries were at the metacarpal-elbow level, and in 9 cases (3%) – elbow-to-arm level. Nineteen patients (6%) suffered a multilevel amputation/injury, e.g. crushing of the whole limb, degloving of several fingers, hand and the wrist, or complete amputation at one level and a near-complete one at the other.

Table 4 explains how the level of injuries varied among the centers. In Poznań the majority of treated injuries involved fingers and the thumb (68 cases, 72%) in comparison to 21 cases of more proximal injuries (22%), whereas in Trzebnica and Szczecin the ratio was reversed: finger-thumb injuries amounted to 31 (38%) and 41 cases (35%) respectively, and proximal injuries to hand, forearm and arm – 48 cases (57%) in Trzebnica, and 65 (57%) in Szczecin.

Table 5 summarizes the numbers of each of the procedures performed within the Service. In 83 cases (28%) a totally amputated limb was replanted; a sub-totally amputated limb, connected with a skin fragment, tendon or muscle, but without blood supply, was revascularized in 95 cases (32%); primary repair of extensive, multitissue injuries without impaired blood supply was performed in 59 cases (20%). Twenty-three cases of degloving and crush injuries with soft tissue defects due to necrosis were managed with flaps, most often of the greater omentum (fig. 4). Finally, 30 patients

Fig. 3. Amputation of four fingers (A, B), pictures sent by mms. Single finger replantation possible (C)

![Fig. 3](image)

Fig. 4. Degloving injury of the whole hand (A), coverage of the hand by pedicled omental flap (B, C) and final outcome at 6 months (D)

![Fig. 4](image)
had their stumps closed primarily because of either massive damage of the amputated part or (less often) the patients’ poor general condition due to multi-trauma.

In four cases supervised on-line by the center in Szczecin a conservative approach was advised until the condition of the limb stabilized. In two cases it was partial degloving of the hand and wrist and in one – a crush injury. In the fourth case, a failed suicide attempt by a bilateral subtotal amputation at wrist by a circular saw. One wrist suffered complete damage of the soft tissues (spaghetti injury) but with the ulnar artery intact, which provided sufficient blood supply. Both bones and both arteries were injured in the second wrist, though minimal blood supply was furnished by the dorsal vessels. However, bad psychological condition of the patient made medical transport unsafe, and the patient did not consent to any other form of treatment. The center suggested stabilizing the wrist with K-wires, wound sutures and conservative therapy with low-molecular weight heparin and dextran. The doctors caring for the patient maintained daily phone and online contact with the center in Szczecin; the hand with impaired blood supply survived, and final reconstruction of both wrists was performed at the center in Szczecin two weeks after the injury, once the patient’s psychological condition had improved.

It goes without saying that severed and extensively damaged limbs not always can be saved despite performed procedures. Table 6 summarizes the treatment efficacy at each of the centers. The number in the first line of the table does not correspond to the one in the previous tables because terminalization cases had been subtracted. The efficacy of replantation/revascularization of 80% is a good result if one takes into account the unfavorable mechanism of some of the injuries (crush, avulsion), prolonged ischemia time due to transportation, and a positive attitude of the specialists from the Service, who often accept difficult cases despite doubtful outcomes.

**DISCUSSION**

Upper limb replantation have been performed in Poland since 1971 (Ryszard Kocięba, Trzebnica). The hospital in Trzebnica was the only center performing such procedures until 1993, when the hospital in Szczecin began to treat hand amputees (1, 2). However, the organizational issues of limb replantation had not been brought up before the Service was actually initiated. The summary of 3 years of work results very encouraging, and warrants the satisfaction of the contributing centers. We are of opinion that starting the Service proved to be a significant organizational advance in

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**Table 5. Types and numbers of the procedures performed in patients managed by the Replantation Service**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Poznań n=96</th>
<th>Trzebnica n=84</th>
<th>Szczecin n=114</th>
<th>Razem n=294</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replantation</td>
<td>22 (23%)</td>
<td>22 (26%)</td>
<td>39 (34%)</td>
<td>83</td>
</tr>
<tr>
<td>Revascularization</td>
<td>42 (44%)</td>
<td>19 (22%)</td>
<td>34 (30%)</td>
<td>95</td>
</tr>
<tr>
<td>Reconstruction</td>
<td>16 (16,5%)</td>
<td>23 (27%)</td>
<td>20 (17%)</td>
<td>59</td>
</tr>
<tr>
<td>Flap covering</td>
<td>-</td>
<td>17 (20%)</td>
<td>6 (5%)</td>
<td>23</td>
</tr>
<tr>
<td>Stump closure</td>
<td>16 (16,5%)</td>
<td>3 (4%)</td>
<td>11 (10%)</td>
<td>30</td>
</tr>
<tr>
<td>Conservative approach</td>
<td>-</td>
<td>-</td>
<td>4 (4%)</td>
<td>4</td>
</tr>
</tbody>
</table>

**Table 6. Effectiveness of the treatment assessed by a survival rate of the operated limbs or digits**

<table>
<thead>
<tr>
<th>Operacja</th>
<th>Poznań n=80</th>
<th>Trzebnica n=81</th>
<th>Szczecin n=103</th>
<th>Razem przeżycie %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replantation</td>
<td>22 (92%)</td>
<td>22 (86%)</td>
<td>39 (82%)</td>
<td>85</td>
</tr>
<tr>
<td>Revascularization</td>
<td>42 (98%)</td>
<td>19 (94%)</td>
<td>34 (85%)</td>
<td>93</td>
</tr>
<tr>
<td>Reconstruction</td>
<td>16 (100%)</td>
<td>23 (100%)</td>
<td>20 (100%)</td>
<td>100</td>
</tr>
<tr>
<td>Flap covering</td>
<td>-</td>
<td>-</td>
<td>17 (100%)</td>
<td>100</td>
</tr>
<tr>
<td>Conservative approach</td>
<td>-</td>
<td>-</td>
<td>4 (75%)</td>
<td>75</td>
</tr>
</tbody>
</table>
the management of the most severe injuries to the upper limb. The work of the contributing centers allowed to save over 200 patients from serious mutilation, thus helping them to regain day-to-day function, and even restoring their work in select cases (fig. 5, 6, 7). Their generally good functional results warrant performing further hand replantations (1-5).

Despite several years of uninterrupted work the Service has maintained its informal character of a bottom-up initiative, and thus lacks any legislative support of the Department of Health (MZ) and the National Health Fund (NFZ). Furthermore, its advising and serving nature implies that the contributing centers are not legally obligated to provide service of any kind to the hospitals of other voivodships. Understandably, this leads to many misunderstandings and quarrels between the doctors caring for amputees and the specialists of the Service declining the admission.

Fig. 5. Guillotine amputation of the had at the wrist level (A, B), a dream of each microsurgeon. The stump of the wrist (C). Two weeks after the replantation (D)

Fig. 6. Excellent function of the hand in patient shown in fig 4, three months after the replantation
Clearly, all of the concerned parties – the mutilated patient, his/her next of kins, as well as the involved doctor – find it best for the patient to be attended to at a reference center, often as distant as several hundred kilometers, where the injury should be evaluated and the limb salvaged. Nonetheless such a procedure consumes a lot of time and resources (air transport), engages multiple health care professionals, and carries substantial risk of e.g. airplane crash due to poor weather conditions. Moreover, empirical data clearly indicates that approximately one-third of all amputated parts are unfeasible for replantation because of several reasons:

- Extensive damage to the amputated part precludes replantation (fig. 1, 2).
- Sometimes replantation is technically possible, nonetheless the unfavorable mechanism of injury poses a great risk of failure, as is the case in crush amputations – despite successful revascularization the limb needs to be re-amputated because of massive muscle necrosis (fig. 2).
- Patients’ estimated time of arrival at the replantation center also may contribute to the decision to decline the admission. Patients admitted to hospitals at a far away regions of the country two hours after the injury (during on-call days of the centers in Trzebnica and Szczecin that means all of the eastern provinces) the estimated time of arrival implicates viability of the part amputated above the metacarpal level, since the time window between the injury and operation should not exceed 6 hours with adequate cooling during the transportation. In such a geographic setting the patient makes it to the Service center after 8 hours, the operation begins an hour later (anesthesiological preps), and the circulation is restored after next two hours. All in all, the total ischemia time often exceeds 11 hours which inevitably leads to massive muscle slough and early re-amputation in a matter of days. However, this scenario does not apply to the thumb and fingers which can be replanted without time window limit.
- In some cases a limb amputation is but a part of multiorgan trauma, and by drawing all the attention of the treating doctors prevents proper diagnostics or directing the patient to the Voivodship Trauma Center (WCU). There are reports of transferring patients to the Service centers with unattended pneumothorax, intraabdominal hemorrhage or intracranial bleeding. These cases required immediate diagnostics, treatment in the setting of intensive care units or urgent operation. Obviously, the injured limbs were not replanted.

Transportation of these patients was a waste of precious time and considerable amounts of money, as well as it unnecessarily put both the land and air emergency medical service teams at risk of accident. Hence, it is crucial that the decision be taken responsibly, rationally, and after much consideration regarding the actual chances for a successful operation. Introduction of the rules of reporting amputation cases, outlined above, resulted in a significant reduction of unwarranted admissions of cases with poor prognostics for replantation. The relatively high rate of primary terminalizations at the center in Poznan (16.5%) probably comes from the predominance of finger injuries treated at this hospital; at the center in Szczecin the high rate of primary terminalizations was limited to the first year of activity during which there were no set guidelines for reporting amputation cases.

There is uniform system for managing hand amputations in the EU. In one of them there are several reference centers, in another one the replantations are performed at every ward fit for microsurgical procedures. It should be
well noted, however, that the prevalence of hand amputations in the countries of so-called „old EU” is much lower than in the post-communist states (3, 4, 5). This difference stems from the use of modern technology, which eliminated exposure to dangerous machine parts during operation, the tradition of observing workplace safety rules, and also from much lower popularity of dangerous machinery – such as circular saws – among population. In the USA over the period of three years 9,400 cases of upper limb amputation were reported; 1,300 patients underwent replantation or revascularization, which means that 400 such procedures were performed monthly. In the UK such cases are operated on in ca. 20 hospitals with plastic and reconstructive surgery or orthopedic wards, experienced in hand surgery and microsurgery (comprising about 20% of all hand surgery wards). Usually, the patient is transported to the nearest unit by ambulance, therefore the use of air transport is rarely being needed. In Germany hand replantations are handled by 15 wards of surgery of the hand, trauma surgery, orthopedics or plastic and reconstructive surgery, experienced in microsurgery. Similarly to the UK, they do not form one coordinated system. On the other hand, in Italy the 15 replantation centers are coordinated by the Italian Society of Surgery of the Hand (Societa Italiana di Chirurgia della Mano); at least one center covers the area of each of the provinces (counterparts of provinces), and the results of their systematically evaluated activity are presented annually online.

Polish Ministry of Health attempted to formalize the work of the Replantation Service and organize it in a way similar to the Transplantation Service, Burn Treatment Centers, or Voivodship Trauma Centers. Sadly, up to date no consensus was reached, mainly because such procedures cannot be financed separately by the National Health Fund, as is the case with the aforementioned centers. Also, negotiations with other surgical wards capable of contributing to the Service with trained microsurgeons end up at the stage of presenting the organization of the Service. Several factors discourage from joining the Service; the most prominent are the lack of separate financing of the work (payment for the on-call and at-ready shifts), and the requirement to work within the basic contract with NFZ, which does not secure the payment for over-the-limit procedures.

CONCLUSION

Nevertheless, it is of crucial importance to expand the Service with at least three more centers in the eastern region of Poland. Particularly, there are wards in Warszawa, Kraków, and Białystok prepared in terms of both the personnel and logistics to substantially contribute to the Replantation Service. This would eliminate the need to use the cumbersome airplanes, in favor of helicopter and land medical transportation. Notwithstanding, for the above mentioned reasons only three centers have been contributing to the Service. However, we still hope for the better. Despite encountered, at times bothersome, difficulties, the replantation teams are enthusiastic about their work, optimistic about its future, and certain that they do make the difference.

REFERENCES


Received: 25.10.2012 r.
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