The Vilkki Procedure as an emergency treatment in an apocalyptical hand injury – a case report and first description

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ABSTRACT
We describe a young man who suffered a severe mutilating injury of the hand and forearm while working as a cheesemaker. He underwent a complex reconstruction of his right adominant hand including a heterotopic thumb replantation into the distal radius and combined with an emergency flow-through anterolateral thigh flap.

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Introduction
Thanks to occupational safety guidelines, major hand injuries have become a rarity in Western countries. This fact has also decreased the exposure of most surgeons to severe hand injuries in Europe. But most initial treatments are performed in local hospitals, not necessarily by specifically trained hand surgeons. Thanks to the publication of Del Piñal, we have a classification of possible injuries of the hand with corresponding treatment guidelines [1]. Based on his article and recommendations in a case of metacarpal hand, we would like to report a case with a severe mutilating hand- and forearm injury of a young cheesemaker.

Methods
A 30-year-old cheesemaker presented in our emergency room with a severe mutilating avulsion injury of the hand and forearm. His right adominant hand was pulled in a cheese cutting machine with six circular saw blades working in opposition to each other. He sustained a midcarpal amputation of the hand, a complete avulsion of the long fingers, a splitting of the forearm with extended palmar soft tissue flap, dorsal extensive soft tissue defect with laceration of the extensor muscles and an open ulnar shaft fracture, defined as third grade (IIIB) according to the classification of Gustilo and Anderson (Figure 1).

The completely amputated thumb, separated at the level of the metacarpal head, was the only finger with enough good soft tissue and bone remaining to use for reconstruction as a functional finger. In the first operation after debridement and osteosynthesis of the ulna, the thumb was pinned to a small decorticated area five centimetres (cm) proximal to the radial styloid in sense of a Vilkki-Procedure (Figure 2). In order to cover the large soft tissue defect, while in addition simultaneously reconnecting a palmar artery of the thumb to the radial artery and a dorsal vein to one in the forearm, an anterolateral thigh (ALT) flap was used as an emergency free flow-through flap (Figure 3).

In the second step four months later, after good healing of soft tissue had occurred, a tendon and nerve reconstruction for the thumb was performed. Initially, a neuroma at the end of the median nerve was resected. The gap between the distal end of the median nerve and the proximal end of the palmar nerve of the thumb was 8 cm. Therefore, a sural nerve graft was used to restore sensitivity (Figure 4).

For motorisation of the thumb, a direct suture of the flexor pollicis longus to restore flexion function was performed. Simultaneously, to accomplish the extensor function, the extensor carpi radialis longus was connected with extensor pollicis longus by a plan- taris longus tendon graft (Figure 5). Subsequent to the operation, an intensive occupational therapy for

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mobilisation and resensibilisation of the thumb was carried out for several weeks.

The thumb had an astonishing good function after the therapy. We measured a pinch grip of five pounds and a two-point discrimination of 10 mm at the pulp of the thumb, while there is a small area, where the sensation is felt on the amputated index finger. It is supposed as a miscellaneous sensation of median nerve. With the gripping ability of the thumb the hand can be utilised for many functions required for daily life. One year after the operation, he was able to return to work in a bigger factory and a more modern

Figure 1. Midcarpal amputation of the hand, complete avulsion of the long fingers till midcarpal with extensive soft tissue defect.

Figure 2. The thumb was fixed to the radius in sense of a Vilkki-Procedure.

Figure 3. The anterolateral thigh flap.

Figure 4. The resensibilisation with a sural nerve graft.

Figure 5. The motorisation of extensor function with a planta-ris longus tendon graft.
workplace with highly automated machinery (Figures 6 and 7).

Discussion
Possibilities for the reconstruction of posttraumatic distal forearm amputation with complete loss of important functional elements of the hand are limited. Some attempts at allogenic human hand transplantation have taken place in the last years [2]. An autogenous microsurgical pinch reconstruction with a single or multiple toe-transplantation is still considered a more realistic treatment for the victims of traumatic hand amputation in order to regain partial hand function. Before the microsurgical era, the Krukenberg procedure was used for reconstruction of bilateral hand loss at a distal level to form a forceps like structure [3]. Later, the Vilkki Procedure was developed as a good alternative to the Krukenberg operation. It was designed by Vilkki in 1981 and applied for clinical use in 1983 [4]. About 20 years later, a case series was published with toe-to-antebrachial stump transplantation in Vilkki’s technique with detailed long term results of 12 patients [5]. The achieved results were generally considered satisfactory. Especially for patients who suffer from loss of vision, such a reconstruction is necessary, as these patients cannot benefit from a prosthetic hand. In some special injuries, where the complete hand has been destroyed except for a single finger, Vilkki has mentioned reimplantation of these fingers in similar ways. But, to our knowledge, this procedure has never been described as an emergency treatment so far.

Del Piñal refers to different goals in the first treatment and debridement of the mutilated hand [1]. He underlines the importance of preservation of vital structures such as joints, flexor tendons and vessels, which will help to construct an ‘acceptable hand’ and achieve a good result. Some compromises in the number of fingers, in motion, in length or sensibility have to be accepted. Piñal’s paper also provides general guidelines for the management of finger amputation and soft tissue problems related to his classification.

In our case, the hand consists of two elements (thumb and opposing digit) to provide a pinch and minimal grasping ability. Thus, it can now be defined as a ‘basic hand’ according to Piñal’s classification. Our original treatment goal to develop a pinch ability, which is highly essential for daily activities, through use of two elements, the thumb and the remaining tissue, was achieved.

This case report shows that the decision and treatment of the first surgeon in the emergency situation is of crucial importance for optimising the therapeutic outcome. In summary, every hand surgeon should be familiar with Piñal’s guidelines.

Disclosure statement
No potential conflict of interest was reported by the authors.

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