Use of Dorsal Metacarpal Artery Flaps in Post Burn Reconstruction – Two Cases Report

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Abstract

Perforator flaps based on the dorsal metacarpal arteries, islanded on a reverse flow pattern are used for reconstruction of two patients respectively with an unstable scar located on the MCP joints and a severe contracture of the ring finger, with full survival and excellent long term results.

Introduction

Treatment of post burn contractures of the hand, implies in most of cases the use of a full thickness skin graft, especially when the contracture doesn’t involve deeper structures but only the skin and the subcutaneous tissues. But in spite of being the “golden standard” in the treatment of these cases, use of a full thickness skin graft carries with it certain inconveniences such as those related to its take, secondary contracture, donor site morbidity.

There are some situations in which instead of using a skin graft, flaps would offer advantages, obviating all the above-mentioned inconveniences. In our practice we found the flaps based on the dorsal metacarpal arteries or on their corresponding perforators very useful. The patients presented sustained burns years ago with respectively an unstable dorsal scar and finger contracture of the ring finger.

The aim of this report is to present two cases with an unstable scar located on the MCP joints and a severe contracture of the ring finger reconstructed with perforator flaps based on the dorsal metacarpal arteries, islanded on a reverse flow pattern.
Material and Method

Patient No. 1

M.P 18 years old suffered a scald burn in her early childhood. The wound healed well, but the scar located over the MCP joints, had kept bothering her thereafter with continuous episodes of ulcerations, and scaling. So she wanted to get rid of the unstable scar. After discussing all the possible options, and having followed her for a long period of time, with special stress on the use of moisturizing creams and sunscreens, she asked for a surgical, why not a permanent correction of this scar. We decided to do a Second Dorsal Metacarpal Flap of the Quaba type (Figure 1). The flap was designed over the second dorsal metacarpal space, having the dimensions 10 by 3cm, reaching proximally the dorsal wrist crease. The Quaba perforator was identified at approximately 1 cm from the tendinous intersections, even though its overlying skin was scarred (Figure 2). The flap was rotated 90°, its proximal end reaching the fifth MCP joint. Donor area was easily closed by primary suturing. The flap showed full survival and uneventful healing, and so did the donor wound (Figure 3). Follow up after 6 months demonstrated excellent result, with improvement even of the esthetic appearance.

Patient No. 2

P.D. 39 years old sustained an electrical burn four years ago. As a consequence he lost his left fifth finger and developed a severe contracture of the left ring finger. Four years after the burn he presents to our clinics, asking improvement of the severely contracted fourth finger. Beside the contracted scar there was stiffness of the PIP and DIP joints with shortness of flexor tendons. After releasing and excising the deeply scarred tissue, the finger regained more than 50 degrees in the range of movement of the PIP and more than 70 degrees over the DIP (Figure 4). Split skin graft from the hypoth-

Figure 1: Unstable postburn scar over the II to IV metacarpal heads, a: the point where the perforator is expected to be, b: design of Quaba flap over the 2nd metacarpal space.

Figure 2: Elevation of the flap, hemostat points to the identified perforator (on the left); flap pivoted over the perforator and rotated through 90° to the defect, after the scar was excised (on the right). Note that the perforator, marked by an X, lies on scarred skin, which poses no problem to flap survival.

Figure 3: Immediate final result, direct closure of the donor site and good color of the flap.

Figure 4: View after release of a severe contracture of the left ring finger. The plan was to put a full thickness skin graft on the defect, but after exposure of the MCP joint capsule, the plan was turned to a Quaba flap based on the IV DMA.

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enar area was applied on the distal wound but a Quaba flap based on the fourth DMA was moved over the MCP joint, were joint capsule was exposed, through a 180° rotation (Figure 5). Donor site was again primarily closed. A Kwire was applied for a four week immobilization. Two months after the operation, the result is still consistent, and the patient is still following physical therapy for functional improvement (Figure 6).

Figure 5: a Quaba flap based on the fourth DMA, islanded over the Quaba perforator; b. scissors point to the perforator identified; c. Flap is being rotated through almost 180 degrees to the palmar defect where the fourth MCP joint has been exposed.

Discussion

Blood supply to the dorsum of the hand and its role in the overall blood supply of the hand skin had received little attention until the report of Maryama and Quaba in the ‘90s on interesting flaps based on the dorsal metacarpal arteries [1, 2]. In fact the first to describe flaps supplied by the dorsal metacarpal system of vessels were Foucher and Braun [3] namely the first dorsal metacarpal artery flap (1DMA).

Classically the DMAs arise from dorsal carpal arch, which lies deep to the extensor tendons at the level of the distal row of carpal bones. The radial artery is the main source of blood supply to the skin of the dorsum of the hand. It contributes to the dorsal carpal arch through the dorsal carpal branch. The supply may be completed medially by the ulnar artery through its dorsal carpal branch. DMAs may have four possible sources of origin; radial artery, the dorsal carpal arch, deep palmar arch and from another DMA. In moving across the dorsum from radial to ulnar the origins follow this sequence.

Generally all the arteries lie deeply in the fascia over the dorsal interosseous muscles between the extensor tendons and are accompanied by venae comitantes. At points approximately 1 cm proximal to the metacarpal heads the second, third and fourth arteries give off larger branches to the skin. The metacarpal arteries then run onwards to the web spaces where they divide into dorsal digital branches for adjacent sides of the proximal phalanges of the index, middle, ring and little fingers.

The anatomy of the second dorsal metacarpal artery is more consistent than that of the 1DMA. In 80% of cases it arises from the dorsal carpal arch and in the remainder from the radial artery, deep palmar arch or 1DMA. A branch to the skin is a consistent finding approximately 1 cm proximal to the metacarpal heads.

The third dorsal metacarpal artery, contrary to the classical description, may arise more commonly from the deep palmar arch than from the dorsal carpal arch [4]. It may on occasion arise from the 2DMA. Its branches to skin are restricted by the overlying extensor tendons to the distal part of the area over the third intermetacarpal area.

The fourth dorsal metacarpal artery is larger than the third. In many cases, perhaps the majority, rather than a single artery there are really proximal and distal branches from different sources which include the deep palmar arch.

Figure 6: Two months after the operation, the result is still consistent, the ring finger has gained 50°-60° of the range of movement, while before operation it was fully contracted, with no extension at all.
In as far as the raising of a flap is concerned, the first thing that one has to be sure of is the consistency of its blood supply, in our case it is translated as: is the DMA on which my flap has to be based consistent?

Some controversy exists in literature regarding the anatomy of the dorsal arterial system of the hand, and the contribution of dorsal and palmar arterial system to the formation of the DMAs [5-8].

These are reports of moderately extended dissection on cadavers regarding the consistency of the DMAs. In a study by Marcelo Rosa de Rezende and associates [8], twenty-six dissections were performed at the dorsum of the right hand of 26 cadavers. The distal cutaneous perforating branches originating from the DMAs were observed in all cases; located an average of 1.2 cm proximal to the MCP joint. The first and second DMAs were visualized in all cases. The third and fourth DMAs were visualized in 96.2% and 92.3% of cases, respectively, which they say is a higher frequency than has been reported in the literature, and which according to them is explained with the different dye solution used, or by the different amount of significance to smaller vessels. They strongly recommend the use of Doppler or even arteriography to document their existence.

A very important aspect of this study was the identification and precise location of the distal cutaneous branches in all DMAs. Their constant anatomy allows planning of the reversed flow DMA flap with greater accuracy and safety, since they represent its pivoting point. Therefore, they conclude that the flaps described by Quaba can be safely employed after the presence of the corresponding DMA is confirmed.

Omokawa et al examined the arterial pattern and size of the first to fifth dorsal metacarpal arteries in 20 fresh cadaver hands [9]. Their connections to the palmar arterial system at the metacarpal head were observed, and the location, number and diameter of skin perforators from each DMA were measured. The first to fourth DMAs were found in all specimens; the fifth DMA was found in 19 of 20 specimens. The mean diameters of the first to fifth arteries at their bifurcation site were 0.6, 0.8, 0.5, 0.4 and 0.2 mm, respectively. Each artery gave off four to eight skin perforators (diameter: 0.1–0.3 mm) between the metacarpal head and base. The first to third DMAs consistently connected to the palmar arterial system, and connections between the fourth and fifth DMAs and the palmar system were found in 65% and 40% of specimens [9].

In a study by Yousif et al the second DMA was found to be the most consistent, with a large distal connection to the palmar vessels which allows both proximal and reverse elevation [10].

Earley and Milner found the fascial variety of the second DMA consistent in more than 97% of thirty hand dissections [11]. They also used Doppler ultrasonic flow meter studies of the vessels in 52 hands, and concluded that such studies are unhelpful in clinical settings.

OPERATIVE TECHNIQUE: Flaps based on the DMAs may be of either direct or reverse flow, but for the purposes mentioned above in our cases, the reverse flow type seems to be more related to reconstructions in the distal parts of the hand. The skin island of the Maruyama pattern flap is designed over the intermetacarpal space and is elevated in continuity with the underlying DMA, which is divided at its proximal end beneath the extensor tendon.

Small branches passing between the finger extensor tendons to reach the overlying skin are preserved [1, 4, 12-13]. Dissection of the vascular pedicle is continued distally to the web space taking care to preserve the connections between the DMA and the branches of the palmar digital arteries.

Quaba has shown that it is not necessary to elevate the DMA with island flaps from the dorsum of the hand if they are based distally on the branches to skin given off by the second, third and fourth DMAs in the area approximately 1 cm proximal to the metacarpal heads [2]. The skin island is orientated longitudinally so as to incorporate the longitudinal vascular network formed by anastomoses between successive branches of individual DMAs. Venous drainage is ensured by the preservation of a substantial cuff of tissue around the arterial pedicle and some subcutaneous veins may also be preserved at the (anatomically) distal end of the flap. Flow in these veins is reversed from normal [14, 15]. The proximal limit of these flaps is determined by the wrist joint and this enables the arc of rotation to include the dorsal aspects of the fingers to just beyond the PIP joints. The donor site on the dorsum of the hand is often amenable to direct closure.

After advent of such flaps in clinical practice their use has been expanded not only to the skin and subcutaneous defects of the adjacent areas but also to most complex reconstructions involving bones, joints, and even nerves [16-22].

Based on this broad previous experience, we are
now more conscious of the usefulness of such flaps in postburn reconstruction. The ad hoc concept of Waterstone and Quaba seems so practical in the field mentioned [23]. According to it, locally available, well-vascularised tissue that will contract minimally and grow with the patient is the ideal for contracture release. This prevents the need for reoperation in children with hand contractures. The consistency of the perforators allows elevation of such kind of flaps even in scarred tissue. Our first case demonstrates this finding, the base of the flap was situated on a scarred area, but with no consequences at all on flap survival. Of course the ideal case of using them is for defects that want such a volume of flap that would allow a direct closure of the donor site, as in our cases.

Conclusions

Perforator flaps based on the DMAs are a very useful adjunct in post burn reconstructions, offering very obvious advantages among which most importantly avoiding the need for a skin graft. Consistency of these perforators, ease of use, and high grades of survival rates, with minimal morbidity to the donor site must be strongly considered as an alternative in special situations of postburn hand contractures, having the disadvantage of offering only limited amount of tissues, so being available as an option only for small defects.

References

23. Waterston SW, Quaba O, Quaba AA. The ad hoc perforator flap for contracture release. JPRAS. 2008;61:55-60.