Parascapular flap in post-traumatic soft-tissue loss at the limbs

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Abstract

Introduction: The aim of this article is to report our results with the use of parascapular flaps to cover limb severe post-traumatic soft tissue defects.

Materials and Methods: Retrospective, descriptive study in a series of 20 patients who received parascapular free flap to cover limb soft tissue post-traumatic combined massive injuries between 2006 and 2017. Patients averaged 30 years old (18 males, 2 females). Injury locations were as follows: 10 in forearm and wrist, one in groin area, seven in leg and two in ankle/foot.

Results: The average follow-up was 3.6 years. We got successful defect coverage in 17 cases. The size of the flaps averaged 24.8 x 10.7 cm. Six cases showed neuro-vascular injuries which needed graft, six were associated with bone loss, 11 required graft skin and four, tendon reconstruction. In all the patients, the donor site was resolved with primary closure with no functional sequelae. Parascapular flaps were combined with scapular flaps in three cases and with latissimus dorsi muscle flaps in three cases. Two flaps failed and we had to carry out amputation in the affected limb; one patient passed away due to massive embolism seven days after the surgery.

Conclusions: Parascapular flaps allowed us to rescue and reconstruct satisfactorily extensive massive defects in 17 out of 20 limbs, with no morbidity in the flap donor area; however, they are not free from complications, and a multidisciplinary approach is required to decrease such complications.

Key words: Parascapular free flap; soft tissue loss; limbs.

Level of Evidence: IV

Colgajo paraescapular en pérdidas postraumáticas de tejidos blandos de las extremidades

Resumen

Introducción: El objetivo de este artículo es comunicar los resultados obtenidos con el uso del colgajo paraescapular para cubrir defectos severos postraumáticos de tejidos blandos en las extremidades.

Materiales y Métodos: Estudio retrospectivo, descriptivo, de una serie de 20 pacientes a los que se les realizó un colgajo libre paraescapular para cubrir lesiones masivas combinadas postraumáticas de tejidos blandos en las extremidades, entre 2006 y 2017. La edad de los pacientes promedió 30 años (18 hombres, 2 mujeres). La localización de las lesiones fue: 10 en antebrazo y muñeca, una en la región inguinal, siete en la pierna y dos en tobillo/pie.

Conflict of interests: The authors have reported none.

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Resultados: El seguimiento promedio fue de 3.6 años. Se logró la cobertura exitosa en 17 casos. El tamaño de los colgajos promedió 24,8 x 10,7 cm. Seis casos presentaron lesiones vasculonerviosas que necesitaron injerto, seis se asociaron a pérdidas óseas, 11 requirieron injerto de piel y cuatro, reconstrucciones tendinosas. En todos los pacientes, el área donante cerró en forma primaria y sin secuelas funcionales. Dicho colgajo se combinó con el escapular en tres casos y con colgajo de dorsal ancho en tres casos. Dos colgajos fallaron y debió amputarse la extremidad lesionada; un paciente falleció por embolia masiva al séptimo día de la cirugía.
Conclusiones: El colgajo paraescapular permitió salvar y reconstruir satisfactoriamente defectos masivos extensos en 17 de 20 extremidades, sin morbilidad para la zona donante del colgajo, pero su uso no está exento de complicaciones, y un abordaje multidisciplinario es necesario para disminuir esta morbilidad.

Palabras clave: Colgajo libre paraescapular; pérdida de tejidos blandos; extremidades.
Nivel de Evidencia: IV

Introduction

Appropriate and timely coverage in extensive soft tissues defects is essential for limbs survival and function. There are multiple options of free flaps, both muscular and fasciocutaneous, which can be used to restore coverage after loss of soft tissues in limbs with severe injuries. The most frequent free fasciocutaneous flaps are: the groin flap, the anterolateral thigh flap, and the lateral arm flap, but they have disadvantages in the sense that these flaps are associated with high aesthetic morbidity at the donor site when they are used for extensive coverage, since primary closure is possible only when they are small.[1-3] The parascapular flap is based on the parascapular cutaneous artery, branch of the scapular circumflex artery; its vascular anatomy was described by Saijo, in 1978,[4] and the first report on its use was published by Santos, in 1980.[5] It can be lifted in isolation or combined with other flaps from the thoracodorsal artery.[1] It allows the surgeon to carry out primary closure at the donator site, with acceptable aesthetic results and minimal morbidity. It has been used for a great variety of reconstructive procedures, mainly for defect coverage in head and neck. [6,7]

The aim of this study is to report our results with parascapular free flaps for the coverage of severe defects in limb soft tissues.

Materials and Methods

We carried out a retrospective, descriptive study in a series of 20 patients operated on between 2006 and 2017, who received a parascapular free flap to cover massive soft tissue injuries in limbs (Table). These soft tissue injuries were considered to be massive because the parascapular flap was indicated as a rescue method for the injured limb; a free flap was proposed as the unique therapeutic option to avoid the amputation of the involved limb. All the injuries were combined—there was loss of soft tissues, fracture, or bone or joint exposure; moreover, there was injury in vessels, nerves, tendons and joints. We excluded patients with extensive soft tissue injuries who received other types of flaps, those who were given a parascapular free flap to cover defects resulting from limb oncologic resection, and those who received this flap to cover head and neck defects.

In 12 patients, we evaluated the host limb with angiography before lifting the flap and, in the remaining eight cases, host vessels were exposed in the areas to be covered and it was not necessary to do angiography. We did not assess pre-operatively the donor site with studies to confirm the presence and location of the parascapular cutaneous artery. Patients were placed in lateral position and the flap was lifted at the same side as the injured limb. There was always only one surgical team. Microsurgical procedures were conducted by an orthopaedic surgeon (CA) with Tang´s Level IV experience (a highly experimented specialized surgeon) at a Level I Trauma Centre. All the patients were treated by the same multidisciplinary team made up of orthopaedists, microsurgeons, therapists, haematologists, infectious disease specialists, general practitioners, surgical technologists, rehabilitators and nurses, who were trained in the management of highly complex patients.

First we prepared the host area, removing extensively all the avascular tissues, necrotic or infected, and identifying and preparing the host pedicle to be used. Once the area had undergone debridement, we assessed the size of the flap and the length of the vascular pedicle to then lift the flap and transfer it. Vascular anastomosis and subsequent adjustment of the flap to the host area were carried out simultaneously to closure at the donor site. We administered intra-operatively 2 papaverine-2 ml-vials, lidocaine-without- epinephrine-2 cm^3, and heparine-1 cm^3 diluted in warm saline solution-100 cm^3 to avoid spasms in the pedicles. Post-operatively we indicated low molecular weight heparin (40 mg every 12 h) and salicylic acid (100 mg every 24 h), as of 12 h after the surgery and during 21 days. Preoperative and postoperative antibiotics were administered as indicated by the Infectious Diseases Department. All the patients stayed from 24 hours to 7 days (2.5 days on average) at the ICU.

Table. Patients, location of the injury and treatment

Patient	Age	Cause	Defect/ Location	Size of the flap (cm)	VAC	Associated injuries	Time until flap (days)	Associated treatment	Follow-up
1	36	Work-place	Forearm/ Wrist	39 x 15	No	Amputation of contralateral upper limb, compartment syndrome, vasculonervous injury, wrist open fracture-dislocation	7	Tendon transfer for thumb flexion	9 years
2	19	Work-place	Forearm/ Wrist	33 x 12	Sí	Fracture in scapular bone, humerus, forearm and wrist, loss of 20-cm ulnar nerve, ulnar artery injury, 7 cm-segmental loss of ulnar bone	3	Ulnar masquelet, término-lateral neurorrhaphy from ulnar nerve to median nerve at wrist level	6 years
3	32	SA	Forearm/ Wrist	28 x 10	No	Fracture in forearm and wrist	5	-	2 years
4	33	SA	Forearm/ Wrist	31 x 12	No	Radial fracture, median nerve injury	2	-	8 years
5	22	Work-place	Forearm/ Wrist	29 x 8	No	Loss of all palm tendon, vascular and nervous structures, carpal dislocation	19	History of nerve free graft and ipsilateral arm lateral flap 20 days before, by pass flap plus tendon transfers x 3, wrist arthrodesis	3 years
6	29	High voltage electrical burn	Forearm/ Wrist	18 x 14	No	Loss of median nerve, radial artery and thumb flexor tendons	9	Amputation one week after the flap	5 years
7	39	SA	Forearm/ Wrist	16 x 10	No	Loss of extensor tendons, nervous injury, dorsal carpal exposure	17	Pedicled latissimus dorsi muscle flap to cover ipsilateral axilar plexus, arm and elbow, extensor tendons tenodesis	5 years
8	30	Work-place	Forearm/ Wrist	20 x 12	No	Loss of extensor tendons, dorsal carpal exposure	1	Tendon graft 30 days after the flap, the patient had been left with silicon spacers (paediatric urologic probes), flap thinning	3 years
9	27	Work-place	Forearm/ Wrist/ Hand	23 x 14	No	Finger amputation x 3, nervous injury	6	-	7 years

(Cont.)

Table. (*Cont.)*

Patient	Age	Cause	Defect/ Location	Size of the flap (cm)	VAC	Associated injuries	Time until flap (days)	Associated treatment	Follow-up
10	24	Work-place	Forearm/ Wrist/ Hand	16 x 9	No	Loss of superficial palm arch, loss of finger nerves x 4	1	Reconstruction of superficial palm arch with free graft from foot vein, free graft from sural nerve for reconstruction of finger nerves.	2 months
11	24	SA	Groin area	27 x 9	Yes	Exposure at the level of femoral vasculonervous bundle and testicle	5	Combined with scapular flap, free skin graft	6 years
12	26	SA	Leg/ Ankle/Foot	33 x 10	Yes	Supracondylar amputation of contralateral lower limb, knee multi-ligament injury, posterolateal complex injury, joint exposure	34	Combined with scapular flap, dermal substitute plus skin graft 14 days later	4 months
13	40	SA	Leg/ Ankle/Foot	30 x 24	Yes	Circumferential loss of soft tissues, tibial open fracture and joint exposure	14	Deep venous thrombosis due to contralateral lower limb thrombosis (possibly due to compression by hip surgical device). Death	-
14	42	SA	Leg/ Ankle/Foot	21 x 12	Yes	Ankle joint exposure, loss of ankle extensor tendons	6	Tendon transfer	2 years
15	21	SA	Leg/ Ankle/Foot	25 x 13	No	Tibio-talar joint exposure	3	-	2 years
16	32	SA	Leg/ Ankle/Foot	27 x 11	Yes	Ankle joint exposure, loss of foot and toes extensor tendons	21	Ankle arthrodesis, fibular non-vascularized free flap (removed from the same limb at the time of the flap) to first ray	2 years
17	25	SA	Leg/ Ankle/Foot	23 x 11	Yes	Tibial pilon fracture	3	-	5 years
18	36	SA	Leg/ Ankle/Foot	29 x 15	Yes	Fibular fracture, ankle joint exposure	4	-	1 month
19	49	SA	Leg/ Ankle/Foot	15 x 8	No	Leg necrosis exposure and soft tissues infection, ankle joint exposure	26	Ipsilateral latissimus dorsi flap to cover leg and ankle defect ipsilateral to injured foot (this one did well)	3 years
20	36	SA	Leg/ Ankle/Foot	13 x 7	Yes	Metatarsal fracture x 3	19	-	6 months

SA = street accident, VAC = *vacuum-assisted closure.*

Results

We manufactured 20 parascapular flaps for the coverage of 20 soft tissue defects in upper limbs (10 cases) and lower limbs (10 cases) (Table). At the time of the surgery patients averaged 30 years old (ranging from 19 to 71). The average follow-up was 3.6 years (ranging from 1 month to 9 years). Eighteen patients were males, and two, females.

Injury locations were as follows: forearm and wrist (10 cases; in two, the injury spread to the fingers), groin area (1 case), leg (7 cases) and ankle/foot (2 cases). The size of the flaps varied between 13 x 9 cm and 39 x 15 cm (24 x 10 cm on average). All the injuries were caused by high energy trauma, and defects were due to motorcycle crashes (6 cases), car crashes (6 cases), and workplace accidents (8 cases). Six patients were treated with early reconstruction (first 72 hours after the accident) and 14 patients, between 3 days and 3 months after the accident (late reconstruction).[2] In nine cases, flap manufacture was delayed using vacuum-assisted closure systems temporarily during average 13 days (ranging from 3 to 34).

Vascular anastomoses were carried out with terminoterminal technique in all the cases, using 4.5 x 6.0 magnifying lenses and 8-0 and 9-0 polyamide stitches. In 14 cases, we conducted anastomosis in one artery and one vein and, in six cases, in one artery and two veins. In one case of upper limb defect and segmental defect in radial and ulnar arteries, we carried out a by-pass flap[9] to cover the defect and simultaneously restore adequate hand circulation.

Since the vast majority of these injuries had been caused by high-energy trauma, patients were admitted with diverse associated injuries that needed different and varied resolutions (Table). Parascapular flaps were combined with scapulars flap in three patients and with (two free and one pedicled) latissimus dorsi muscle flaps in three cases (Figures 1-3). Four patients had tendon injuries that required reconstruction: three of them were resolved by one-time tendon transfer, whereas the other one was resolved by two-time tendon reconstruction with initial silicon spacer (paediatric silicon urologic probe) to then, at a second stage, 21 days after the first surgery, carry out the free graft; such flap, on the back of the forearm and the hand, had to be thinned six months later. In eleven cases, we resorted to skin graft for the coverage of exposed areas which did not require free flap coverage and were next to the injured area that was covered with parascapular flap; in one of this cases we associated a dermal substitute (Integra®).[10] Ten patients had joint exposure; other six, open fracture, and one required the use of cement with antibiotic to fill a bone defect. In one patient with localized injury in their distal third of the leg, their ankle and their foot, and segmental loss of their first metatarsal, we carried out fibular free flap for reconstruction in the same surgical time.

Two patients suffered flap necrosis, and we decided to carry out amputation in their affected limb following flap failure. The first patient had suffered burns with high ten-

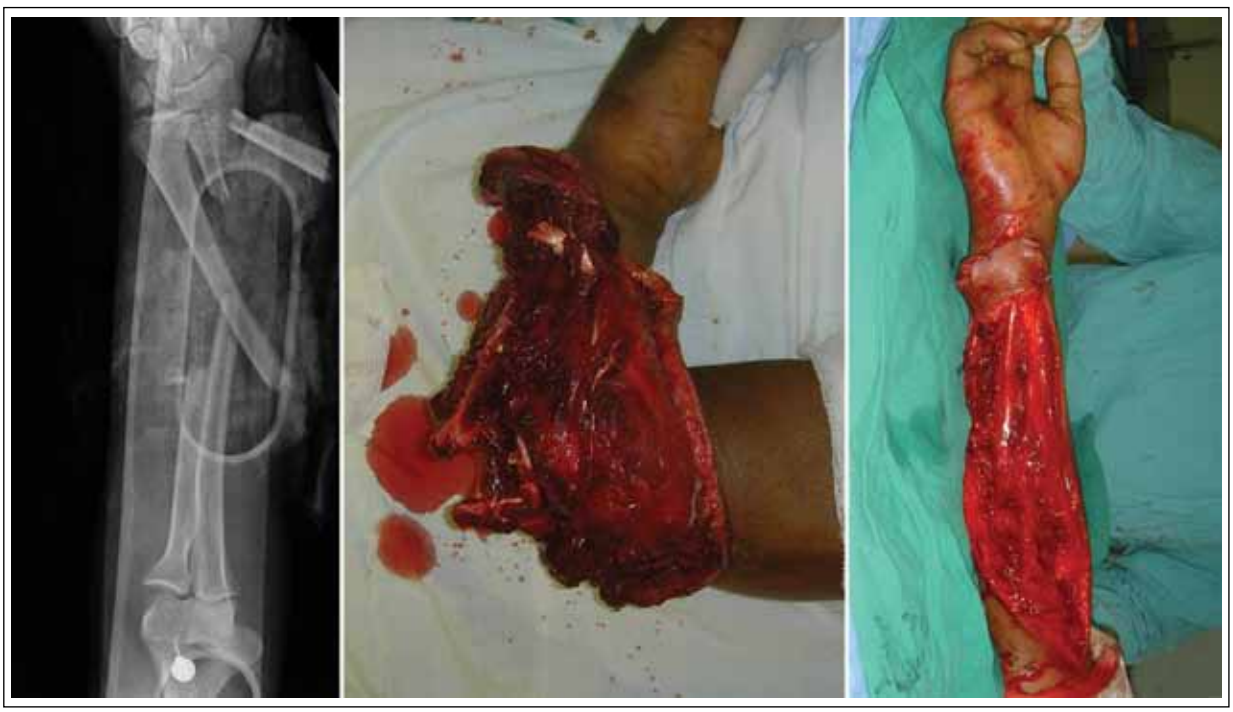

Figure 1. Nineteen-years old patient. Countryside accident. Segmental loss of ulnar nerve (15 cm).

Figure 2. Treatment. Open reduction and internal fixation in wrist and ulnar bone. Masquelet technique in ulnar bone. Termino-terminal transfer from ulnar nerve to median nerve.

Figure 3. Good long-term aesthetical and functional results.

sion wiring in their upper limb, and the patient was amputated at forearm-proximal third level; the second failed flap occurred in a diabetic patient with simultaneous extensive injury in their leg, which was successfully covered with a free latissimus dorsi flap, and injury on the back of their ankle and foot, which was covered with parascapular flap. It was the latter the one which failed, and we had to carry out amputation at mid-foot level. In both flaps, we sutured one artery and one vein, but we cannot say objectively if failure was arterial or venous, because the patient was not evaluated to find it out. One patient who received a combination between a parascapular flap and a free latissimus dorsi muscle flap for severe and extensive defect coverage in their lower limb passed away due to massive embolism seven days after the surgery; in this case, we could not quite determine the origin of such massive embolism; apparently it originated in the uninjured contralateral lower limb. The remaining patients did favourably. In all the patients the donor site received primary closure with functional sequelae neither for the shoulder nor for the upper limb. No patient reported either pain or dissatisfaction with the aesthetic looks of donor site. There was no partial necrosis in the flap.

Discussion

Decision making at the time of amputating or rescuing a limb seriously injured is difficult and requires a multidisciplinary approach, high complexity Centres and experience. The progress that has been made in knowledge about vascular anatomy and skin circulation has allowed specialists to develop a great variety of pedicled and perforating flaps.[11-16] The parascapular flap has proved to be versatile, rough and reliable. When it is used for defect coverage in severely injured limbs it can replace fasciocutaneous defects with tissues similar to those which have been lost.[4,6,17-19] Fasciocutaneous flaps offer surgeons significant advantages as compared with muscle flaps, such as simplicity, availability and versatility, without sacrificing muscle tissue.[16,17] In our series, we evaluated 20 fasciocutaneous flaps to reconstruct 20 limb massive injuries and got satisfactory results in17 of the injured limbs and primary closure of flap donor site without functional sequelae in all the cases. The main limitation of this study is its retrospective design in a series of cases without control group.

The parascapular flap has a number of features—it is a thin flap, with scarce villi, great potential for the coverage of extensive defects, and it can be used as an independent fasciocutaneous flap or in combination with a scapular flap (two cases in this series), in combination as a mixed myo-fascial-cutaneous flap (three cases in this series with latissimus dorsi muscle) or as a chimerical bone-myo-fascial-cutaneous flap, and it is associated with low morbidity. In 1982, Hamilton and Morrison, [19] and Nassif et al.[20] showed that the parascapular flap is reliable because it is easy to lift and its vascular anatomy is trustworthy; [21-27] it has been proved that the vascular pedicle in the parascapular flap is more invariably found than that in the anterolateral thigh flap. [20,27-30] In the 20 parascapular flaps assessed in this series, we did not find any vascular anomaly during pedicle dissection and, based on procedures previously reported, we did not carry out patients' preoperative evaluation to confirm their presence.

The effective total length of the pedicle in the parascapular flap is 11 to 14 cm-long on average,[20] but it can be lengthened if dissection is spread to the scapular angular artery.[31] In an anatomic study, Busnardo et al.[32] compared anatomic characteristics between the anterolateral thigh flap, the parascapular flap and the anterolateral arm flap in 20 corpses. They did not find any significant difference in neither the flap thickness nor the diameter of the vascular pedicle. However, they did find significant differences in pedicle length, with a 13.43 ± 3.92 cm-long pedicles in anterolateral thigh flaps as compared with 9.07 ± 1.2 cm-long pedicles in parascapular flaps. The length of the pedicle in the anterolateral thigh flap depends on intramuscular dissection of the circumflex femoral lateral artery, what hinders the procedure; however, this technical difficulty is not to be seen during vessel dissection in parascapular flaps. In our series, the length of the pedicle was never insufficient, because we invariably prepared and dissected the host pedicle before lifting the flap, acknowledging beforehand the required length of the flap pedicle.

One of the advantages of the parascapular flap is its size, because its skin square can be as much as 30 cm-long if it includes the ascending and descending branches of the subscapular circumflex artery.[33] The flap can be enlarged medially by including the scapular flap based on the horizontal branch of the scapular circumflex artery, and there are reports on up to 45 x 12 cm-flaps safely carried out.[20,27,34,35] In five cases in our series we used 30 cm-flaps and bigger ones with no complications. Izadi et al.[7] highlight as a parascapular flap advantage the possibility of primary closure at the donor site; in our series, we were able to carry out primary closure at the donor site in all the cases, even when we lifted combined flaps (parascapular/scapular).

The distribution of the subscapular vascular system is recognized by its potential for the design of mixed flaps, allowing surgeons to transfer fasciocutaneous, muscle and bone flaps in unique blocks. [36] Nassif et al.[20] described the elevation of a mixed flap combining the latissimus dorsi muscle (thoracodorsal artery) and the parascapular flap (subscapular circumflex artery)—both

components share the subscapular artery as original vessel, and the whole has been called a "based on a common branch" "mixed" flap.[37,38] In our series, we combined parascapular flaps with scapular flaps in three cases, and parascapular flaps with (two free and one pedicled) latissimus dorsi muscle flaps also in three cases. The parascapular flap is characterized by the low complication rates at the donor site it is associated with.[7,30,39] Rolls et al., [39] in their series of parascapular flaps, did not find major complications such as seroma, infection or wound dehiscence; they only verified wound healing delay in two cases. Klinkenberg et al.[30] reported seroma in two patients out of 20 with parascapular flaps. In our series of 20 patients, we did not find complications such as wound dehiscence, seroma or infection.

One of the main limitations reported in association with flaps which are based on subscapular artery axes is the position of the patient during the design and lifting of the flap.[32] Our experience coincides with that of others's,[7,40] in that there is no evidence of greater technical difficulty in this patient's position when the flap is elevated at the same side as the limb to cover is. Reports show that this flap has been manufactured successful and safely even in very young patients and the elderly.[41,42] In our series, patients were between 19 and 49 years old, and 55% were younger than 30.

Flaps allow patients to have definite and early reconstruction of soft tissue defects and improve limb functional results,[43,44] with primary wound healing, prevention of infection and decrease in costs and hospital admission.[45]

Treatment of these complex limb injuries by a multidisciplinary approach, at high complexity Centres and focusing on the patient's general status and bone and soft tissue injuries gives these patients with severe limb injuries a valid option of reconstruction in terms of functional and aesthetic results. However, patients should be aware of potential complications and associated morbidity. In our series, results were satisfactory in 17 out of the 20 patients with post-traumatic massive soft tissue injuries who were thought of as just able to avoid amputation of the involved limb by flap manufacture.

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