

Use of Propeller Flap in the Coverage of Soft-Tissue Injury in the Lower Limb*

Utilização de retalho em hélice para cobertura de lesões de partes moles em membro inferior

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Abstract

Objective To evaluate the use of a propeller flap to cover soft-tissue injuries in the lower limb.

Materials and Methods A retrospective study, with review of medical records, and a convenience sample of 14 patients operated between July 2018 and June 2019. The following clinical aspects were evaluated: sex; age group; type of injury; cause of the injury; initial diagnosis; affected location; techniques for incision and identification; surgical planning; flap design; postoperative period; result of the propeller flap; and complications.

Results The sample was composed of male patients (100%), with a mean age of 36.4 years, and 92.7% of the injuries resulted from motorcycle accidents, mostly on the right side (71.4%). The surgical planning of the propeller flap followed the same procedure in all cases. Immediate postsurgical complications were present in 35.7% of the cases, and they included excessive bleeding (14.3%), partial necrosis (14.3%), and flap dehiscence (7.1%). In total, 13 patients had excellent coverage, and only 1 had flap loss.

Conclusion The propeller-flap technique to cover lesions in the lower limb proved to be a good alternative in most cases evaluated, with a good surgical result, although complications were observed in some cases.

Keywords

- ▶ soft tissue injuries
- ▶ perforator flap
- ▶ lower extremity

Resumo

Objetivo Avaliar o uso de retalho em hélice para cobertura de lesões de partes moles em membro inferior.

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Materiais e Métodos Estudo retrospectivo, de revisão de prontuários e amostra de conveniência, com 14 pacientes operados entre julho de 2018 e junho de 2019. Foram avaliados os seguintes aspectos clínicos: sexo; faixa etária; tipo de lesão; causa da lesão; diagnóstico inicial; local acometido; técnica de incisão e identificação; planejamento cirúrgico; desenho do retalho; pós-operatório; resultado do retalho em hélice; e complicações.

Resultados A amostra era composta por pacientes do sexo masculino (100%), com idade média de 36,4 anos, e 92,7% das lesões eram decorrentes de acidente motociclístico, a maioria do lado direito (71,4%). O planejamento cirúrgico do retalho em hélice seguiu o mesmo procedimento em todos os casos. As complicações pós-cirúrgicas imediatas estavam presentes em 35,7%, e incluíram sangramento excessivo (14,3%), necroses parciais (14,3%), e deiscência do retalho (7,1%). No total, 13 pacientes apresentaram ótima cobertura, e em apenas 1 houve perda do retalho.

Conclusão A técnica do retalho em hélice para a cobertura de lesões em membro inferior mostrou-se uma boa alternativa na maioria dos casos avaliados, com um bom resultado cirúrgico, embora tenham sido observadas complicações em alguns casos.

Palavras-chave

- ▶ lesões dos tecidos moles
- ▶ retalho perfurante
- ▶ extremidade inferior

Introduction

The World Health Organization (WHO) estimates that about 50 million victims of traffic accidents live with disabilities or sequelae.¹ In Brazil, data from the Unified Health System (Sistema Único de Saúde, SUS, in Portuguese) indicate an estimated cost of R\$ 2.9 billion (Brazilian currency) due to traffic accidents.²

Pedestrians, cyclists, and motorcyclists are the groups most vulnerable to traffic accidents. Most patients are victims of motorcycle accidents, and they are young (25 to 35 years old) and male.³ Polytrauma resulting from a motorcycle accident causes more serious injuries to the head and extremities, with the main causes of death being fractures of the limbs and pelvis, followed by trauma, laceration or rupture of abdominal organs, and traumatic brain injuries.⁴

Traffic accidents lead to orthopedic trauma. Advances in medicine stimulate the improvement of surgical techniques.⁵ The injuries include complex injuries to the lower limbs, which are a challenge regarding which type of treatment is most appropriate.⁶ Reconstructive surgeries are complex due to the anatomical characteristics that lead to difficulty in treating soft-tissue injuries.⁷

The flaps consist of mobilized tissue that is kept attached to its vascular pedicle, ensuring adequate irrigation.⁸ The use of propeller flaps to cover soft-tissue injuries started in 1991 as a surgical approach to the substantial loss caused by trauma. Its use in the clinical practice has improved as knowledge about the cutaneous vascular system increased. The factors involved in choosing the most appropriate surgical technique include the location, the extent of the lesion, the exposure of noble structures, and the surgeon's experience with reconstruction techniques.⁹

The use of the propeller flap to cover lesions is an option when the area to be treated is small to medium in size,

located in a well-vascularized region, and surrounded by healthy tissues. In this technique, we should consider the quality and volume of the transferred soft tissue, the orientation of the scar and the adequate planning of the flap, to enable the direct closure of the donor site without tension in the area. When these indications are respected, the propeller flap has a high success rate, low morbidity, fast recovery, good esthetic results, and reduced cost.¹⁰

The aim of the present article was to evaluate the use of a propeller flap to cover soft-tissue injuries in the lower limb, as well as to identify the main causes of trauma and the complications resulting from the surgical technique.

Material and Methods

The present is a retrospective cross-sectional study, which was carried out by reviewing medical records and using a convenience sample. Data were obtained from the electronic records of the patients cared for and registered in the Conecte/w (Wareline do Brasil, Goiânia, GO, Brazil) software at the orthopedics emergency room of Hospital de Urgências, from July 2018 to June 2019, for surgical treatment of soft-tissue injuries in the lower limbs. Data collection was carried out with the Medical Archive and Statistics Sector (Setor de Arquivo Médico e Estatística, SAME, in Portuguese).

After selecting the medical records, the following clinical aspects were evaluated: 1) sex; 2) age group; 3) type of injury; 4) cause of the injury; 5) initial diagnosis; 6) affected site; 7) incision and identification technique; 8) surgical planning; 9) flap design; 10) postoperative period; 11) result of the propeller flap; and 12) complications. The data were collected in a specific form, and for the purpose of comparison, photographic records of the surgical and postsurgical procedures were used, and the frequencies were estimated in relation to the variables.

Results

Within 1 year, 14 individuals with soft-tissue injuries in the lower limbs undergoing the propeller-flap surgical technique were identified. Regarding gender, all patients were male ($n = 14$; 100%). The mean age of the patients was 36.4 ± 8.48 years, ranging from 26 to 48 years, with the highest frequency being that of young adults (25 to 29 years; $n = 4$; 28.6%) and adults between 45 and 49 years of age ($n = 4$; 28.6%). Regarding the type of injury, most patients presented soft-tissue injuries, with exposure of noble structures such as tendons, and without associated open fractures ($n = 08$; 57%); the right side was the most affected ($n = 10$; 71.4%).

Motorcycle accidents were the main cause of injury among patients undergoing the propeller-flap surgical procedure ($n = 13$; 92.7%). Only 1 (7.1%) patient suffered an injury resulting from a car accident. Among the affected areas (► **Table 1**), the posterior aspect of the distal third of the right leg was the most frequently affected ($n = 5$; 35.7%), followed by the medial distal third on the same side ($n = 3$; 21.5%).

The design of the cover flap of the wound varied from 4×3 cm to 11×4 cm. The flap dimensions ranged from 12 cm^2 to 70 cm^2 , with a mean size of 29 cm^2 and an interquartile range of 21 cm^2 to 38 cm^2 . Immediate postsurgical complications were present in 35.7% ($n = 5$) of the cases, and they included excessive bleeding ($n = 2$; 14.3%), partial necrosis ($n = 2$; 14.3%), and flap dehiscence ($n = 1$; 7.1%). In 42.9% ($n = 6$) of the cases, skin grafting was necessary to cover the donor area (► **Table 1**). Regarding the result of the surgical technique used, thirteen patients had excellent coverage, and in only one there was loss of the flap.

As for the surgical planning, in all cases, the procedure summarized below was followed. Perforator flaps were

indicated to cover wounds in the distal third of the leg and perimalleolar region in the ankle. The arterial axes were the posterior tibial artery and the anterior tibial artery. For anteromedial and posterior wounds, the option was for the posterior tibial artery and lateral anterior tibial artery. The choice of the perforator flap followed the aforementioned criteria. The patient was anesthetized in the operating room, and exsanguination of the lower limb was performed. Afterwards, the flap design was made, and the probable point of location of the pedicle (perforating artery) was marked, but it was impossible to use the Doppler to identify the pedicle due to the unavailability of this equipment in the hospital.

For the surgical technique, the procedure used in the cases is summarized below. After drawing the flap and marking the probable location of the perforating artery, a skin and subcutaneous incision was made up to the fascia. The fascia was raised subfacially to locate the perforating artery for the nutrition of the flap. The perforating artery was identified, with confirmation of its origin in the main axis in the posterior or anterior tibial artery and entry into the flap through the fascia. Afterwards, a template was made with a compress cut to the size of the wound to be reconstructed up to the pedicle. The flap was then dissected and raised close to the fascia. In all procedures, we ensured that the fascia was part of the flap, since it would be responsible for the perfusion of the flap. Afterwards, the flap was rotated 180° , with a larger flap covering the wound. Subsequently, the tourniquet was released, and the flap perfusion was verified, and the suture was performed. The failure in the donor area was covered with skin graft when necessary.

The postoperative period described in the medical record consisted of daily changing the non-compressive dressings and maintaining the limb elevated. After hospital discharge, the outpatient follow-up was carried out. Between two and four

Table 1 Summary of cases of soft-tissue injury submitted to the propeller-flap surgical technique

Case	Age (years)	Flap (cm)	Affected location	Complications	Additional procedures
1	42	10×2	Medial face of the distal third of the right leg	No Complications	Skin graft
2	37	7×7	Medial face of the distal third of the left leg	Bleeding	Flap slimming
3	48	10×7	Distal posterior face of the right leg	No Complications	Skin graft
4	46	8×3	Posterior face of the distal third of the left leg	Bleeding	None
5	48	11×4	Distal posterior face of the right leg	No Complications	Skin graft
6	48	7×5	Medial face of the distal third of the right leg	No Complications	None
7	35	9×4	Medial face of the distal third of the right leg	No Complications	None
8	35	5×3	Medial face of the middle third of the right leg	No Complications	None
9	26	6×4	Distal posterior face of the right leg	Partial flap necrosis	Skin graft
10	28	5×3	Distal posterior face of the right leg	Flap dehiscence	None
11	27	4×3	Medial face of the middle third of the right leg	No Complications	None
12	32	6×4	Lateral face of the distal third of the left leg	Partial flap necrosis	None
13	27	6×4	Lateral face of the distal third of the right leg	No Complications	Skin graft
14	31	8×3	Medial distal third of the left leg	No Complications	Skin graft



Fig. 1 (A) Soft-tissue injury with tendon exposure; (B) location of the perforating artery; (C) dissection of the flap; (D) flap rotation; (E) cover and graft; (F) postsurgical outcome.

weeks, good flap maintenance and lesion coverage were already reported in the medical record. ► **Figures 1** and **2** present the photographic records available in the medical file referring to the surgical procedure with propeller flap performed on patients in cases 1 and 5 respectively (► **Table 1**).

Discussion

In the state of Goiás, Brazil, there was an average of 91 traffic accidents per day in the first half of 2019. About 60% of the victims of traffic accidents in the capital city of Goiânia, during this period, were on motorcycles. Male individuals

aged between 20 and 29 years represent 42% of the total of people involved in motorcycle accidents in our country,¹¹ data similar to those observed in the present study. Sado et al.¹² evaluated the characteristics of victims of motorcycle accidents admitted to the Emergency Hospital from December 1st to 31, 2007, and observed that the majority were male (91%), and the most frequent injuries and surgical interventions were located in the lower limbs (53.3%).

Shen et al.,¹³ when evaluating patients with soft-tissue injuries examined at a hospital in China, observed that most were male (80.6%; $n = 29$), and the average age was 39.7 years. Mendieta et al.¹⁴ evaluated the use of the propeller



Fig. 2 (A) Soft-tissue injury with tendon exposure; (B) location of the perforating artery; (C) dissection of the flap; (D) flap rotation; (E) postsurgical outcome.

flap to cover soft-tissue injuries to the lower limbs in individuals examined at a hospital in Nicaragua, in which the mean age of the patients was 32 years, and the male gender accounted for 75% of the cases, numbers that are lower than those observed in the present study.

Lesions in the lower limbs have a low ratio of fatal cases; however, they require reparative, corrective surgery, and, in some cases, amputations, which can compromise the patients' quality of life.⁵ When assessing the profile of individuals involved in motorcycle accidents in the city of São Paulo, Brazil, Debieux et al.¹⁵ observed that most injuries occurred in the lower limbs (53.9%), and more frequently in the age group between 21 and 24 years (45%). Rezende et al.,⁹ when evaluating the epidemiological profile, surgical treat-

ment and postoperative results of patients with complex traumatic injuries to the lower limbs, observed that the motorcycle accident was responsible for the majority of the injuries (37.8%), and that the lower third of the leg was the region most affected by trauma (50.4%), followed by the medial third (32%).

Exposure of noble areas is common when lesions occur in the distal third of the leg, requiring that they be covered with good quality tissues and vascularity.⁶ The use of flaps to cover injuries resulting from trauma in soft tissues offers similarities in texture to the injured area, good appearance, and partial or complete repair of the donor site. The size of the flaps depends on the extent of the area to be covered.¹³ Shen et al.¹³ reported in their study flaps ranging from 10×5 cm to 34×18 cm,

values higher than those reported in the present study. Sasidaran et al.¹⁶ performed reconstruction of soft-tissue defects in the lower limb in 6 patients from a Malaysian hospital in which the flap dimensions ranged from 3 × 3 cm to 10 × 5 cm, values closer to those observed in the present study.

Bajantri et al.¹⁷ suggested the use of propeller flaps for defects of up to 50 cm²; however, D'Arpa et al.¹⁸ stated that there are other factors that should be considered when establishing a maximum flap size, since it depends on the patient's body and leg size, skin flaccidity, flap volume, adequate closure of the donor site, and countless other factors. The authors conclude that propeller flaps are still an attractive option for small and medium defects, especially at the level of the leg and foot.

When evaluating the postsurgical results, Nelson et al.¹⁹ found a partial loss rate of 11.6%, lower than that observed in the present study (14.3%). Sisti et al.¹⁰ conducted a literature review between 2005 and 2015 and estimated the rate of postsurgical complications resulting from the propeller-flap technique at 22.6%, and the highest frequency was observed in the lower limb (31.8%), with partial flap necrosis and venous congestion being the most frequent complications. In the present study, the complication rate was higher than the mean observed by Sisti et al.,¹⁰ but with similarity in relation to the most frequent complications.

Conclusion

Despite the limited number of medical records of patients undergoing the propeller-flap technique to cover lesions in the lower limb, the use of this type of flap proved to be a good alternative in most of the evaluated cases, with good surgical results, although complications were observed in some cases.

Conflict of Interests

The authors have no conflict of interests to declare.

References

- Rodrigues BL, Portela AR, Pastore Neto M, Drumond AF. Lesão grave de partes moles decorrente de acidente motociclístico. *Rev Med Minas Gerais* 2013;23(04):536–539
- Aquino Y. Acidentes no trânsito deixaram mais de 1,6 milhão feridos em 10 anos: seis de cada dez casos graves são de pessoas entre 15 e 39 anos. Empresa Brasil de Comunicação, Brasília, 23 mai 2019, Saúde. Disponível em: <http://agenciabrasil.ebc.com.br/saude/noticia/2019-05/acidentes-no-transito-deixaram-mais-de-16-milhao-feridos-em-10-anos>. [Accessed: July 23 2019]
- Andrade SM, Jorge MH. Características das vítimas por acidentes de transporte terrestre em município da Região Sul do Brasil. *Rev Saude Publica* 2000;34(02):149–156
- Koizumi MS. Padrão das lesões nas vítimas de acidentes de motocicleta. *Rev Saude Publica* 1992;26(05):306–315
- Saad FT, Almeida KG, Almeida PY, et al. Reconstrução de dorso do pé com retalho supramaleolar lateral de fluxo reverso em menor de 4 anos de idade. *Rev Bras Cir Plást* 2015;30(02):324–332
- Chang AJ, Milcheski DA, Nakamoto H, Tuma P Junior, Lobato R, Ferreira MC. Conduas em traumas complexos de partes moles de membros inferiores no HCFMUSP. *Rev Bras Cir Plást* 2013;28(3, Suppl)1–103
- Macedo JL, Rosa SC, Silva AA, Filho Neto AVR, Ruguê PH, Scartazzini C. Versatilidade do uso do retalho do músculo gastrocnêmio medial na reconstrução de lesões de partes moles de membros inferiores. *Rev Bras Cir Plást* 2016;31(04):527–533
- Teixeira Neto N, Chi A, Paggiaro AO, Ferreira MC. Tratamento cirúrgico das feridas complexas. *Rev Med (São Paulo)* 2010;89(3/4):147–151
- Rezende MR, Rabelo NT, Benabou JE, et al. Cobertura do terço distal da perna com retalhos de perfurantes pediculados. *Acta Ortop Bras* 2008;16(04):223–229
- Sisti A, D'Aniello C, Fortezza L, et al. Propeller Flaps: A Literature Review. *In Vivo* 2016;30(04):351–373
- DETRAN. Departamento estadual de trânsito. Estatísticas. Disponível em: <http://inside.detran.go.gov.br/acidente/index.htm>. [Accessed: July 14 2019]
- Sado JM, Morais FD, Viana FP. Caracterização das vítimas por acidentes motociclísticos internados no hospital de urgências de Goiânia. *Rev Movimenta* 2009;2(02):49–53
- Shen L, Liu Y, Zhang C, et al. Peroneal perforator pedicle propeller flap for lower leg soft tissue defect reconstruction: Clinical applications and treatment of venous congestion. *J Int Med Res* 2017;45(03):1074–1089
- Mendieta M, Cabrera R, Siu A, Altamirano R, Gutierrez S. Perforator Propeller Flaps for the Coverage of Middle and Distal Leg Soft-tissue Defects. *Plast Reconstr Surg Glob Open* 2018;6(05):e1759
- Debieux P, Chertman C, Mansur NS, Dobashi E, Fernandes HJ. Lesões do aparelho locomotor nos acidentes com motocicleta. *Acta Ortop Bras* 2010;18(06):353–356
- Sasidaran R, Zain MA, Basiron NH, Ajik S. Propeller flaps in lower limb reconstruction: case series. *Anaplastology* 2013;3(01):1–4
- Bajantri B, Bharathi RR, Sabapathy SR. Wound coverage considerations for defects of the lower third of the leg. *Indian J Plast Surg* 2012;45(02):283–290
- D'Arpa S, Toia F, Pirrello R, Moschella F, Cordova A. Propeller flaps: a review of indications, technique, and results. *BioMed Res Int* 2014;2014:986829
- Nelson JA, Fischer JP, Brazio PS, Kovach SJ, Rosson GD, Rad AN. A review of propeller flaps for distal lower extremity soft tissue reconstruction: Is flap loss too high? *Microsurgery* 2013;33(07):578–586