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The SCIP propeller flap: Versatility for reconstruction of locoregional defect☆

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Summary *Introduction:* Abdominopelvic defect is frequently a challenge. Several local flaps exist for this anatomical region, but sequelae of the donor site, particularly with regard to morbidity on the anterior abdominal wall, are frequent. Although the utility of the superficial circumflex iliac artery flap is well established in its free form as well as its pedicled form described by McGregor, the superficial circumflex iliac artery perforator (SCIP) propeller flap is rarely reported. The purpose of this study is to highlight the possible range of locoregional coverage using the SCIP propeller flap.
Methods: Between 2012 and 2018, 72 SCIP flaps were made in the propeller version to cover locoregional defects of various etiologies in our units.
Results: The dimensions of SCIP flaps were on average 20.2 cm long (9–39) by 8.2 cm wide (5–18). The average rotation angle was 163.3° (range 130–180). In sixteen patients, SCIP flaps were bilateral. In five cases, the reconstruction was combined with a contralateral Tensor

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Listing of each author's role/participation
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Dr. Charlotte Vaysse (MD, PhD): manuscript preparation, manuscript review.
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Fascia Lata (TFL) flap to cover a very large defect. Two SCIP flaps necrotized following global venous congestion and a TFL flap was performed in rescue. No complications appeared on the donor site and the patients did not have any functional complications related to the reconstruction. Particular care was taken to respect the lateral cutaneous nerve of the thigh.
Conclusion: The SCIP propeller flap provides a reliable and versatile method for reconstructing abdominoperineal defect, including the thigh root region to the trochanters with low donor site morbidity.

Introduction

The groin flap is one of the oldest flaps along with the latissimus dorsi flap and the tensor fascia lata flap. It was originally described in 1972 by McGregor and Jackson for hand defect coverage with a pedicled flap technique retaining a broad skin bridge at its base,[1] and the natural evolution was the use of this same flap, but in free flap version, by Daniel and Taylor in 1973.[2] The McGregor flap has been used for a long time because it offers many advantages: easily concealable sequelae of the donor site, possibility of using a large surface of glabrous skin, absence of microsurgery and therefore, rapidity. On the other hand, its development as a free flap has taken a long time to overcome some notable disadvantages: short pedicle, arterial and venous variability, bulky flap, and complications of the donor site for some authors.[3] The groin flap was also used locally in advancement flap to reconstruct trochanteric, penile,[4] perineal or abdominal areas.

Koshima et al.[5] evoked for the first time in 2004, a groin flap based on a superficial circumflex iliac artery perforator. The superficial circumflex iliac artery perforator (SCIAP) or SCIP Flap was indeed described as a perforator flap of the groin of great thinness allowing local or regional defect coverage and overcoming many of the disadvantages of the traditional groin flap.[6] This discovery led to the development of the free perforator inguinal flap. The rather variable anatomy (path, length of pedicle, dominance of one of the branches) has long been put forward, which has led to numerous anatomical studies.[7,8] Accurate mapping is now available for the path of the superficial and deep branches of the SCIA (Figure 1). Thus, its free form is widely used for the treatment of areas with loss of substance requiring thin coverage[9] such as the joints, the upper limbs (especially the hands),[10-12] the head and neck (including the oral cavity and the external acoustic meatus)[13-18] and the lower limbs.[5,6,12] The SCIP flap now appears more suitable than the anterolateral thigh (ALT) flap or thoracodorsal artery perforator (TDAP) flap for covering the loss of substance on the dorsal surfaces of the feet or hands.[6] In addition, a chimeric use is possible for the reconstruction of the hands or the face using several skin paddles[10] or bone taken from the anterior superior iliac spine.[13]

On the other hand, the use of this flap as propeller remains anecdotal, with only seven cases reported in the literature: four unilateral SCIP (three scrotums[19-21] and one trochanter[5]) and three bilateral SCIPs (one scrotum,[22] one perineal[12] and one penis with urethra[23]). Indeed, even for a local reconstruction like the urethra, some authors prefer to use the free SCIP to have more freedom of modeling.[24]

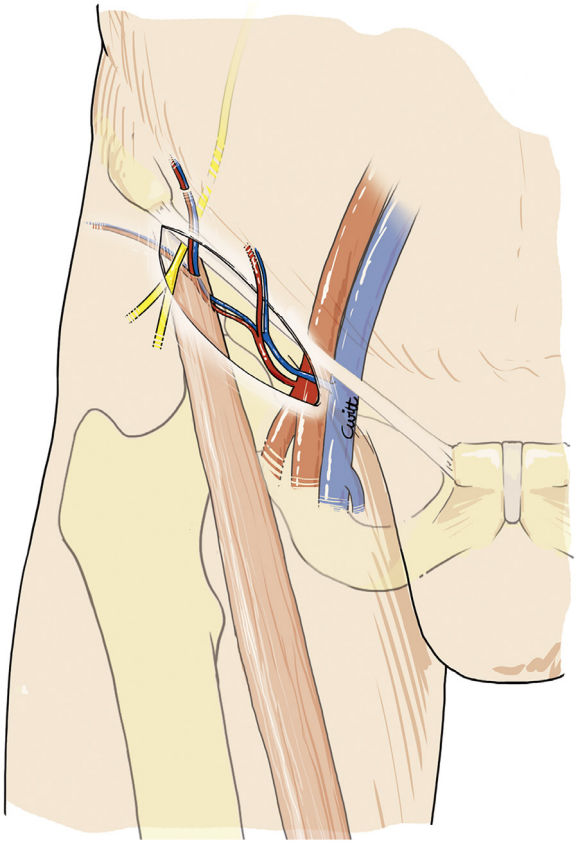

Figure 1 Path of superficial and deep branches of the superficial circumflex iliac artery and their relationship with the sartorius muscle and the lateral cutaneous nerve of the thigh.

The purpose of our study is to highlight through our series the great versatility of local or regional coverage possibilities using the propeller SCIP flap, whether used alone, combined with a contralateral SCIP or another local flap.

Methods

Patients were identified who benefited from reconstruction with a SCIP propeller flap in the plastic surgery departments

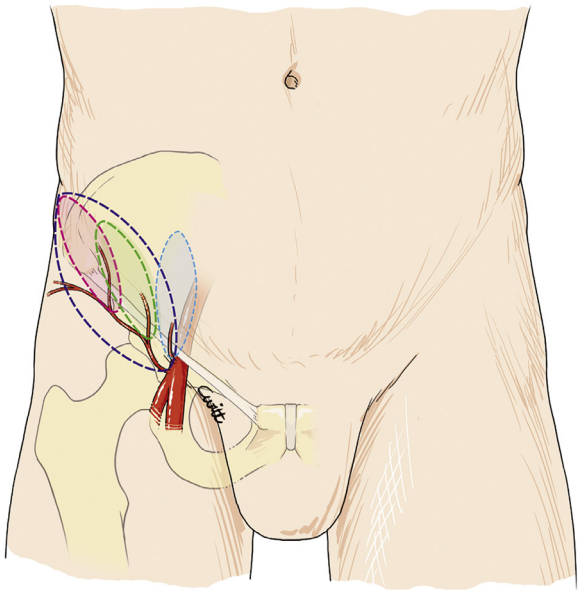

Figure 2 Designs of a flap's skin paddle; the harvested site of the skin paddle varied according to the chosen perforator as well as the defect to cover.

of the Montpellier and Toulouse University Hospitals by the same operator (BC) from November 2012 to November 2018.

Data were compiled concerning: the demographic characteristics of the patients; the characteristics of the loss of substance; the surgical technique: unilateral, bilateral, or in association with another flap; the characteristics of the flap: dimensions in cms, rotation of the pedicle; postoperative complications; evaluation of donor site sequelae.

Surgical technique

Preoperatively, the location of the superficial (medial) and deep (lateral) perforators was detected and labeled using Doppler ultrasound. In the majority of cases, precision on the path of the perforators was achieved using the color doppler ultrasound with a high frequency probe (13 MHz).

The flap was drawn supine on the axis of the inguinal fold. The skin paddle was designed with eccentric perforators using the propeller flap technique in order to optimize the maximum rotation distance. The harvested site of the skin paddle varied according to the chosen perforator as well as the defect to cover (Figure 2). The dimensions of the flaps were always slightly longer than the size of the defect in anticipation of skin retraction, but after taking care to perform a pinch test to ensure the possibility of direct closure. No magnifying glass was used for the dissection.

The first incision was made on the inferolateral edge of the flap to the fascia superficialis in the manner of Hong et al.[25] The lateral 1/3 of the flap was taken in the suprafascial plane, then the harvesting deepened and the aponeurosis of the sartorius muscle was harvested on one to two cm^2 so as to preserve the deep perforator, or continued in the suprafascial plane if we only collected the superficial perforator. The dissection of lateral to medial allowed us to identify a dominant perforator of the deep branch then in a second phase, more medially, a dominant perforator of the superficial branch. The dissection continued in a retrograde fashion through the fascia along the superficial circumflex iliac artery until a pedicle of length and caliber sufficient for the twist was obtained. Particular care was taken to respect the lateral cutaneous nerve of the thigh.

In general, we performed surgical debridement of the wound in the perineal area after the flap was made to ensure its viability, except in cases of cancer or when the loss of substance had already been cleansed. In one case, a pig skin matrix (PERMACOL®) was required to close the peritoneal exposure in connection with resection of a parietal tumor (case 2).

The island flap was then ready for transfer. Depending on the type of reconstruction, tunneling was performed. The donor site was always closed first on a Redon drain. The flaps were then modeled and sutured to the perineal skin on silicone slides with Skoog stitches. A pillow was placed under the knee on the side of the donor site to reduce the tension at the inguinal fold for the first 48 h.

Results

From November 2012 to November 2018, 72 SCIP propeller flaps were performed on 56 patients for various locoregional defects (Table 1). In sixteen patients, SCIP flaps were bilateral. In five cases, the reconstruction was combined with a Tensor Fascia Lata flap (TFL) to cover very large defects. For two patients, a delayed procedure was performed due to the large size of the flap and to secure our reconstruction in a difficult vascular context. The size of the SCIP flap skin paddle averaged 20.2 cm long[9–39] by 8.2 cm wide.[5–18] The average rotation angle was 163.3° (range 130–180). Twenty-eight flaps were tunneled subcutaneously. All donor sites were self-closing without any secondary complications. Patients were released from the hospital with adequate perineal coverage, allowing for a resumption of their daily activities.

Regarding complications, only two flaps necrosis occurred following venous insufficiency and coverage was ensured by a TFL flap. One occurrence of venous congestion was found in a patient in the context of radiotherapy, which healed after hirudotherapy. Six flaps were detwisted within 6 h postoperatively because they showed signs of mixed arteriovenous suffering. A rotation 24 h later allowed reconstruction without necrosis of the flaps.

Particular care was taken to respect the lateral cutaneous nerve of the thigh. Indeed, its section can be the cause of pain or insensibility of the thigh. During our dissections, this nerve was cut completely once. A secondary defatting is planned for 2 patients.

Case 1 (Figure 3)

A 70-year-old patient presented lymph node recurrence of inguinal melanoma with extensive skin invasion. A large excision procedure was decided upon with revision of lymphadenectomy, and a coverage by SCIP propeller flap rotated at 180° was performed. Healing was achieved

Table 1 Population and flap characteristics.

Age, median (range)		52 (26-75)
Etiologies, *n* (%)		
	Hidradenitis suppurativa	31 (55.4)
	Oncologic	14 (25)
	Scarpa skin necrosis (vascular surgery)	5 (9)
	Chronic osteomyelitis	3 (5.4)
	Burn injury	3 (5.4)
Comorbidities, *n* (%)		
	Smoker	16 (28.6)
	Arteriopathy	3 (5.4)
	Diabetes	3 (5.4)
Type of flap	Unilateral SCIP	40
	Bilateral SCIP	32
Size median; cm (SD)		20.2 (9-39) × 8.2 (5-18)
Arc of rotation (range)		163.3° (130-180).
Complications, *n* (%)		
	Complete flap necrosis	2 (2.8)
	Arteriovenous insufficiency rectified by pedicle derotation (detwisted)	6 (8.3)
	Venous congestion	1 (1.4)

SCIP (superficial circumflex iliac perforator flap).

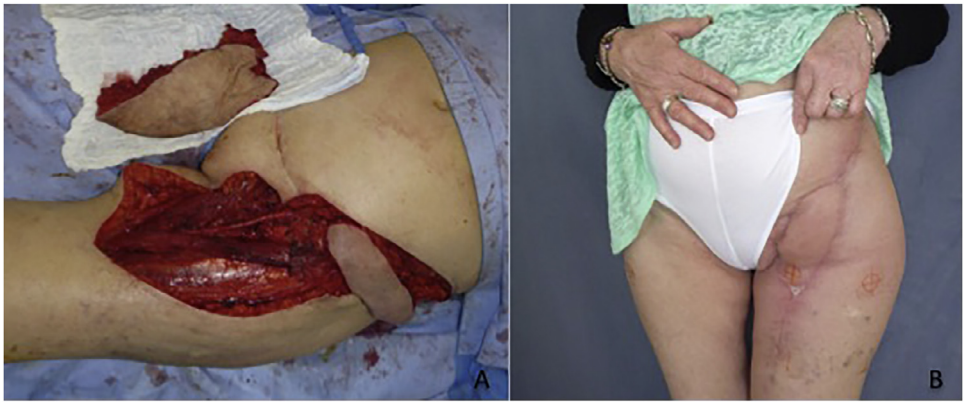

Figure 3 Case 1: (A) Lymph node recurrence of inguinal melanoma with extensive skin invasion, tumor resection and flap planned. (B) After tumor excision, SCIP flap harvested. (C) Complete healing at 4 months follow up with possibility to begin adjuvant radiotherapy.

without difficulty and adjuvant radiotherapy could be performed. However, the patient died 6 months later following metastatic pulmonary invasion of melanoma.

Case 2 (Figure 4)

A 65-year-old patient presented with T4N0R0 right scrotal warty inguinal carcinoma with cutaneous/subcutaneous development of the right inguinal region extending about 16 cm in height, with intramuscular involvement of the lower portion of the right rectus muscle and right pectinus. The surgery consisted of a monobloc excision of the abdominal-inguinoscrotal tumor with sacrifice of the right testicle and a straight radical inguinal lymphadenectomy. A parietal reconstruction was made using PERMACOL® plate. The large substance loss was covered at the same time by a flap of left SCIP in association with a right TFL flap. Both donor sites were closed without tension. A thin skin graft was performed on Day 9 to cover the penis. Clinical control at 4 months showed uncomplicated healing with resumption of a completely normal life.

Case 3 (Figure 5)

A 46-year-old patient presented with a left hydrocele. In the follow-up period, the patient presented a left scrotal abscess requiring drainage of the latter and then a left orchiectomy due to testicular necrosis. Despite the antibiotic treatment, the patient presented a right orchi-epididymitis with testicular focal necrosis requiring the realization of a right orchiectomy. Because of resistance to antibiotic treatment, a major abcedation formed at the level of the scrotum resulting in trimming with sacrificial skin and poor-quality peri-lesional skin. The loss of substance and the damaged peri-lesional skin were covered by a flap of bilateral SCIP. The two SCIP flaps were tunneled to the

Figure 4 Case 2: (A) Verrucous carcinoma in the inguino-scrotal region. (B,C) After tumor excision, a combined TFL and SCIP flap reconstruction was planned. (D) Immediate result of the reconstruction. The donor sites were self-closing. (E) Complete healing at 6 months follow-up with no recurrence of the tumor.

Figure 5 Case 3: (A) Bilateral scrotal retraction and abcedation related to bilateral post-infection orchiectomy, with a bilateral SCIP flap planned for coverage of scrotal defects. (B) After excision, SCIP flaps harvested, during tunneling. (C) Immediate result of the reconstruction. The donor sites were self-closing. (D) Complete healing at 3 months follow-up with no recurrence of the infection and with a decrease in penile edema.

scrotum. Both donor sites were closed without tension. The complete healing without skin flap necrosis was obtained in three weeks despite a passage in intensive care for severe sepsis due to a new strain of Pseudomonas aeruginosa resistant to antibiotics.

(Figure 6 and Supplementary material Fig. 1).

Discussion

Perforator flaps are increasingly used for abdominoperineal reconstruction. For many authors, these flaps have become the first choice in this indication to limit donor site sequelae. The SCIP flap has restored the usefulness of the groin donor site and allows great versatility in reconstruction.

Abdominoperineal defects have been the subject of many methods of coverage in the literature. Depending on the location, we can find, for the lower part of the lower abdomen and the anterior perineum, Pudendal Internal Artery Perforator flap (PIAP),[26,27] Medial Circumflex Femoral Artery Perforator flap (MCFP),[26] Inferior Gluteal Artery Perforator flap (IGAP), Transverse Rectus Abdominis Myocutaneous flap (TRAM), Deep Inferior Epigastric Artery Perforator flap (DIEP),[27] perineal perforator-based island,[28] vertical and oblique rectus abdominis,[29] uni- or bilateral external oblique,[30] lower abdominal flap,[31] medial thigh

Figure 6 A) A 59-year-old woman with a chronic osteitis post-sarcoma resection, with the need to resurface the scar of the trochanter and the lateral side of the thigh to change the femoral nail. A large SCIP propeller flap was planned. B) After scar excision, delayed SCIP flap harvested and sutured in place on a fatty dressing. Wound was dressed by negative pressure wound therapy for two weeks. C) Complete healing at 3 months follow-up after a second time procedure, with scheduled orthopedic surgery.

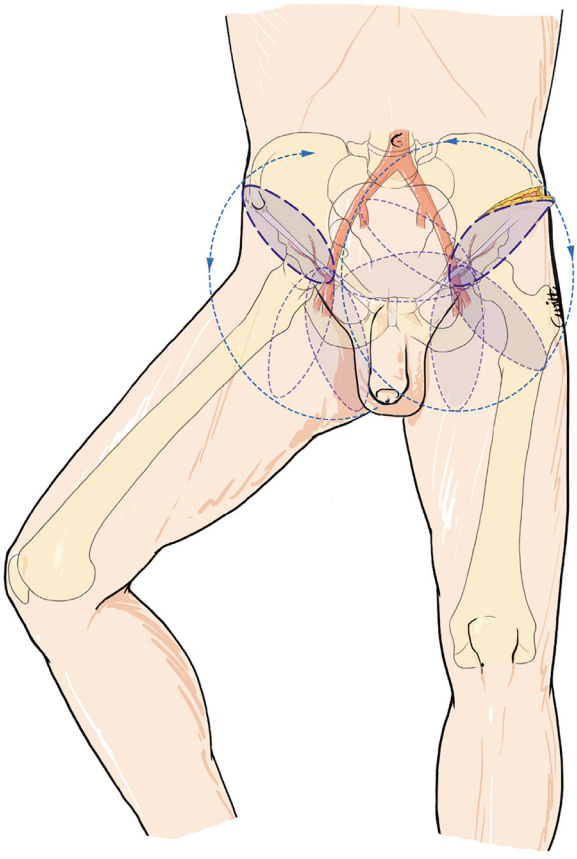

Figure 7 The potential arcs of rotation of the SCIP propeller flap, versatility of local coverage.

lift.[31] For the thigh root we find the Anterolateral Thigh flap (ALT),[32,33] Anteromedial Thigh flap (AMT), Tensor Fascia Lata flap (TFL),[34] gracilis flap,[35] and even free flap.

The SCIP propeller flap can offer a good quality and sustainable coverage at the level of the abdominoperineal region. The anatomical region covered by the SCIP propeller flap extends globally from the umbilicus to the anus vertically and from one trochanter to the other horizontally. In this series, we saw that this flap can cover a loss of substance in a circle of about 25–30 cm centered on the emergence of the superficial circumflex iliac artery (Figure 7). In addition, the coverage area may vary from medial to lateral depending on whether a flap is taken from the ACIS, from the superficial perforator, or the deep perforator. Thus a flap can be harvested from the deep perforator which is lateral, to cover a loss of substance close to the emergence of ACIS.[36] Also, the skin paddle can be taken even if an abdominoplasty scar separates it in two, in the presence of an iliac crest bone graft, or a previously grafted skin. Indeed, this is made possible because of this double-tiered vascularization which allows robustness in the pediculated version. A delayed procedure is possible to secure the reconstruction when the skin paddle is very large, or the local possibilities of reconstruction are poor. Finally, it is possible to supercharge a SCIP flap by taking a perforator from an intercostal artery, or to make it sensitive by including in the flap the lateral cutaneous branch of the intercostal nerve.[37]

When the SCIP flap is insufficient to entirely cover the defect, it may be associated with other local flaps to ensure that there is no tension on the reconstruction. Its most frequent associations are with the contralateral SCIP,[12] the TFL, the DIEP or the ALT. Also, a SCIP propeller flap is sometimes used in rescue flap in case of failure of a first-line reconstruction or in emergency on exposure of a noble structure.

The SCIP propeller flap seems to have a place of choice in the reconstruction of this anatomical area as the morbidity of its donor site is much less than that of an abdominal flap like the TRAM or the DIEP. There are numerous other advantages of SCIP propeller flaps. This is a naturally thin fasciocutaneous flap, which can be defatted before suturing or harvested in its ultra-thin version with a suprafascial harvest[3,11,38] with or without microdissection[9]; moreover, the donor site has little morbidity,[12] is self-closing in most cases and does not expose a noble structure. The dimensions of the SCIP can be very large[8] because the perforators have pathways in the axis of the flap, oblique at the top and externally.[39] We can also carry out a preliminary expansion if necessary.[21] Ciudad et al. proposed a postoperative crepe bandage immobilization method between the thigh and the leg (knee in 90° flexion and hip in slight external rotation) to avoid any risk of disunion of the donor site for wide flaps.[40]

The SCIP is vascularized by one or more perforators from the superficial circumflex iliac artery which is a direct branch of the common femoral artery. This direct

origin of the common femoral artery is a great advantage because it often allows more proximal than vascular surgery repairs of the lower limbs (an advantage compared to ALT which is more distal). The vascularization is provided by a medial superficial perforator and/or a deep lateral perforator. Many studies have shown that one of the two is large and dominant in the vascularization of the flap.[5,8] This could be a limiting factor, but we know from Strauch et al.[41] (repeated by Yoshimatsu et al.[42]) that the deep branch is always present. In addition, a very precise mapping is now possible preoperatively with the handheld acoustic Doppler used to identify the emergence of perforators, and then the color Doppler[12,16,18,36,43] to identify the perforators and their pathways, to identify which is dominant, and finally to harvest our flap optimally. In addition to this whole preoperative approach, Feng et al.[36] referred to an intraoperative adaptation using either the superficial perforator, or the deep perforator, or the superficial inferior epigastric artery if the SCIA is hypoplastic (Figure 2). Finally, if the vascularization is overall of poor quality and the receiving site well vascularized, a switch to a total skin graft is possible. This idea is echoed by Yoshimatsu et al.[42] who developed, for its free use, a technique to lengthen the arterial pedicle using it to connect the transverse branch (which follows laterally to the deep branch), allowing an elongation (about 4 cm) of the arterial pedicle of the SCIP flap by reverse flow. The diameter of the transverse branch is often about 0.8 mm, which is not so different from the SCIA diameter at the proximal region.[42,44] The length of the pedicle of the SCIP and its size are nevertheless smaller than that of the ALT or the other loco-regional flaps.

The SCIP flap can nevertheless present complications. These are mainly due to surgical malpractice. During the harvesting of the flap, a lesion of one of the perforator or lateral femoral-cutaneous nerves of the thigh may occur, causing in the first case a risk of flap failure and in the second, meralgia or loss of sensitivity of the lateral side of the thigh. These sensitivity problems are often definitive, although they partially improve over time.

After the twist of the flap, venous congestion is most common, but arterial compression can sometimes occur. The latter is mainly due to a lack of squeletization of the pedicle which during the twist of the flap can cause a constriction. Also, when a large skin paddle is harvested, we advise against significant defatting of the flap during the first surgical phase to limit any risk of hypoperfusion and limit the complications of partial necrosis which causes often major healing delays. Thus, in case of failure of SCIP propeller flap coverage, it is necessary to know how to harvest the other local flaps, such as the TFL which is a flap of choice[34] as in our case number 4.

Conclusion

The use of the SCIP propeller flap for coverage of abdominoperineal defects, including the thigh root area up to the trochanters, appears to be a reliable method with high plasticity in the reconstruction methods. Despite these excellent results, other clinical series are needed to corroborate these positive results.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.bjps.2019.03.016.

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