Evaluation of Keyston Design Perforator Island Flap in Treatment of Soft Tissue Loss

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ABSTRACT:

BACKGROUND:

Closure of skin and soft tissue defects is a main stream procedure in the field of plastic and reconstructive surgery .Keystone perforator island flap is a curvilinear trapezoidal shape. It is essentially elliptical in shape and it is long axis adjacent and parallel to long axis of defect. We focused in this study specifically on pressure ulcer and traumatic wound as an example of chronic and difficult wounds.

OBJECTIVE:

To evaluate keystone design perforator island flap as reliable versatile method for closure of soft tissue defect.

PATIENTS AND METHODS:

In this prospective study, keystone perforator island flap applied to 11 patients , 7 of them were pressure ulcer and 4 of them with traumatic soft tissue defect.

RESULTS:

Keystone flap used in 11 patients in this study , all of patients showed complete flap survival without even minor necrosis, only one patient developed wound dehiscence ,otherwise all patients showed complete recovery without any sequalae.

CONCLUSION:

Keystone flap is reliable ,safe ,easy to perform ,cost effective flap, with low rate of flap failure and no donor site morbidity, can be used as effective method of wound closure even in chronic and unhealthy wound.

KEYWORDS: keystone, pressure ulcer, island perforator flap

INTRODUCTION:

Reconstructive ladder remains the cornerstone for dealing with wound whether acute or chronic. More complex wound needs higher up the ladder the has been to climb. Traumatic wound is example of acute one and chronic wound broadly categorized into diabetic ulcer, pressure ulcer ,and venous ulcer. With great understanding of blood supply of the skin, depending on random flap and delay has been reduced and many new emerging flaps with defined vascular anatomy had introduced.([1,2,3,4])

In 1989 ,the era of perforator flap had begun when both k and S describe inferior epigastric artery perforator flap without muscle harvest .perforator flap had many advantage including versatility of its design ,low donor site morbidity, less functional defect ,and improved postoperative patient recovery. However, perforator flap needs meticulous dissection, and there is great variability in the size of the perforator.[5,6]

The basic principle of keystone perforator flap is the one of named cutaneous territory to augment the reconstructive supply of island keystone perforator flap (conjoint arterial and neurarterial supply). It is name keystone flap is due to resemblance of this flap to Roman archway of keystone.[7]

Classification of Keystone flap According to Behan, keystone flap can be classified into 4 types:

I. skin incision only
II. A) division of deep fascia
    B) with spilt skin graft to secondary defect
III double keystone slap
IV rotational keystone flap , omega variant is a mixture of type III p

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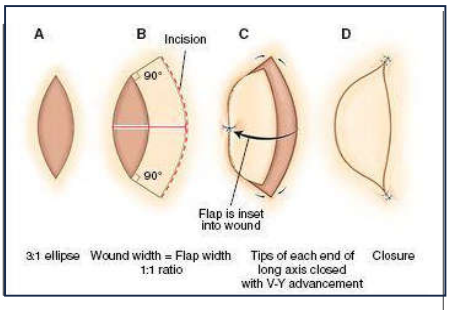
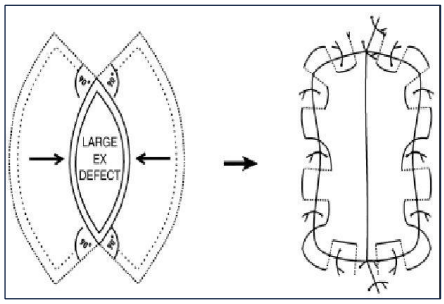


Fig (1): Type 2 keystone flap[7]



Fig(2): type 3 keystone flap[7]

PATIENT AND METHODS:

Between January 2017 to march 2018, 11 patients presented with cutaneous (soft tissue) defect in leg (traumatic injury) and in sacral and ischial region(pressure ulcer), those patients were surgically treated by using keystone perforator island flap in Al–shaahed Ghazi Al-Hariri hospital and Al–Wasity teaching hospital.

Those patient with severe crush injury to the leg were excluded from our study, those patients with grade I and II pressure ulcers also being excluded.

Preoperative complete history and proper physical examination were done for all of our patient who were include in this study. Examination of the wound was focused on the assessment of following points, the site, the size, the degree of contamination, and any associated injures.

Preoperative investigation was done for all of our patients including hemoglobin level, bleeding profile, liver (albumin level and total serum protein for pressure sore patient), renal function test and virology screen

Wound swab for culture and sensitivity test were send routinely for all patients. All of our patients were subjected to local wound care before operation till the wound become healthy and clean and ready for coverage.

All patients are photographed pre ,intra and postoperative. Follow up for average of 6 months and up to 1 year in pressure ulcer patients. Preoperative informed consent was obtained from all of our patients. No colostomy done for all pressure ulcer patients.

Patients data are shown in table -1- below

Table (1): Patients data

Pt. No.	Sex	Age	Site of defect	Causes of defect	Size of defect (cm)	Associated injuries
1	Male	55year	Sacral	Pressure ulcer	4x6	Exposed bone (grade IV ulcer)
2	Male	65 year	Anterior lower 1/3 of leg	RTA	3x2.5	Exposed bone
3	Male	35 year	Calcaneum	Blast injury	4x6	Exposed bone
4	Male	45 year	Anterior upper 1/3	Blast Injury	3x2.5	Exposed bone
5	Male	50 year	Sacral	Pressure ulcer	6x10	Exposed bone (grade IV ulcer)
6	Male	25 year	upper 1/3 of leg	RTA	4x5	Soft tissue defect
7	Male	32year	Sacral	Pressure ulcer	6x8	Exposed bone (grade IV ulcer)
8	Male	46 year	Ischeal	Pressure ulcer	3x4	Exposed bone (grade IV ulcer)
9	Male	33 year	Sacral	Pressure ulcer	7x10	Exposed bone (grade IV ulcer)
10	Male	42 year	sacral	Pressure ulcer	10x10	Exposed bone (grade IV ulcer)
11	Male	30 year	Ischeal	Pressure ulcer	4x8	Exposed bone

Operative procedure:

Operations were done under general anesthesia and under tourniquet control in lower leg. And in case of pressure ulcer all patients were paraplegic and operated under sedation only. The surgical operation began by excision and debridement of the wound and try converting the wound into elliptical shape with its long axis is parallel to cutaneous nerves, vein, and or know nearly vascular perforators. We did not need doppler allocation for all of our patients. After that we started marking our planned keystone flap according to type of keystone chosen (according to width and location of defect) .

After that, the operation is began by incising the borders of the previously marked flap, according to size and site of defect, incised the skin and subcutaneous tissue, then by blunt scissor, blunt dissection is done through the subcutaneous tissue, this blunt dissection is done circumferentially around the flap keeping it attached to its underlying tissue. After that, division of the deep fascia along the convex surface of the flap (IIA), this facilitated its advancement to close the defect site. In two cases (calcaneal defect) and (large sacral pressure ulcer) used omega (Ω) variant of flap, where we planned the keystone flap as previously mentioned; type III; but the movement of the flap is differ, in such variant undermining one end of the flap and raised it in subfascial plane, the undermined portion of the keystone flap is rotated in 90 degree and sutured to the opposite end of keystone flap .Then fixing the flap, first the concave side of the flap is suture to the edge of the defect by using 2 /0 polyglactin 910 intradermal suture, and in order to facilitate adequate mobilization of the flap without tension, both end of donor site of the flap is closed in v-y shape manner by using intradermal suture. After that the convex surface of the flap is suture to edge of the donor site also by using intradermal 2 /0 polyglactin 910. Then complete suturing the flap using half buried 3/0 Nylon horizontal mattress or traditional horizontal mattress. Suction drain is inserted at separated incision in cases of pressure ulcer and fixed by using purse string silk suture. Light dressing is then applied to the flap, and patients discharged on the next day keeping him on injectable 3rd generation cephalosporin for 5 days postoperatively, suction drain removed at 1 week .At 14 day removal of stiches, regular follow up at least 6 months postoperative.

Figure no (3)case no.(7); 32 years old male with paraplagia withl grade IV sacral pressure ulcer measuring 6*8 cm (a) preoperative (b) after wound excision (c&d) marking of flap

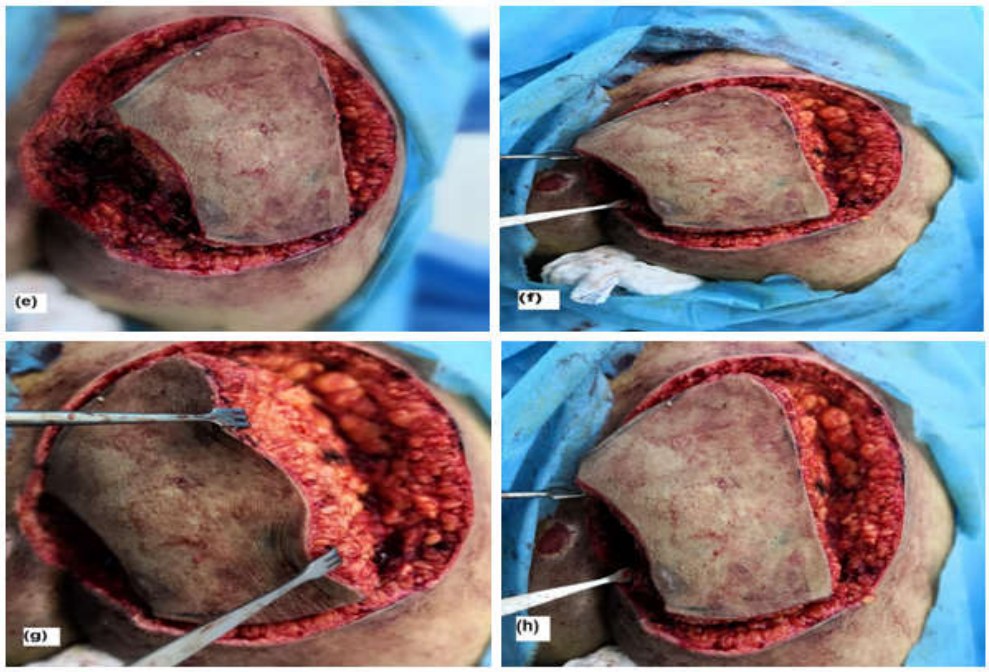


Figure no (4): (e) after incion of flap border down to fascia (f,g&h) show degree of flap advancment

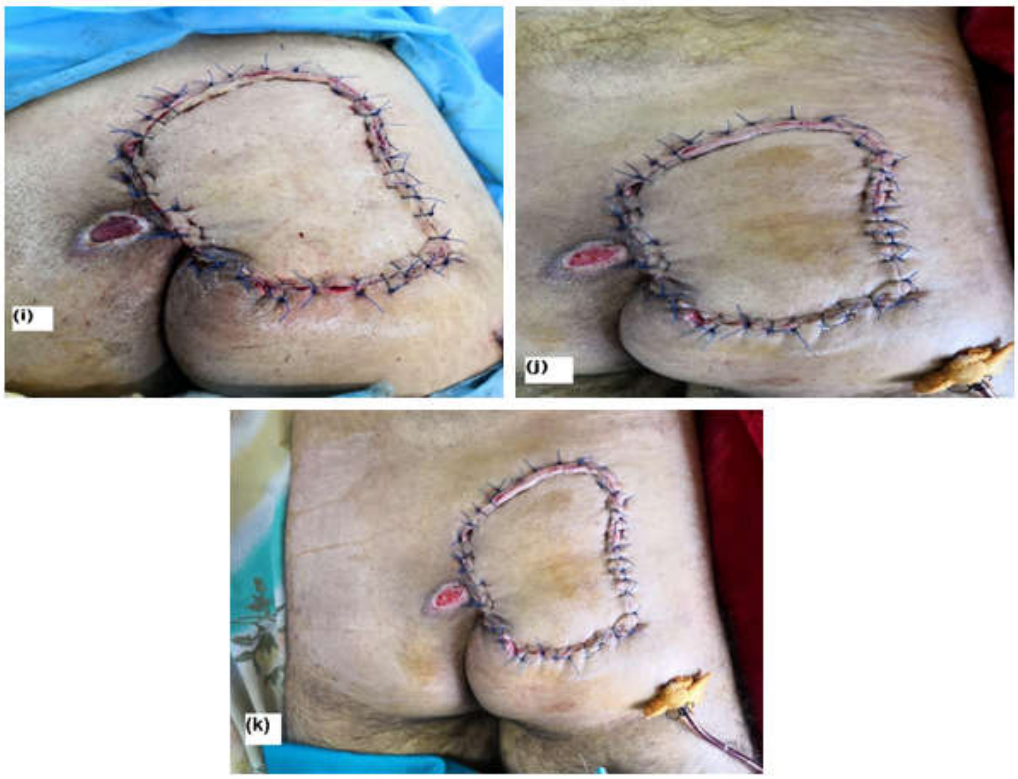
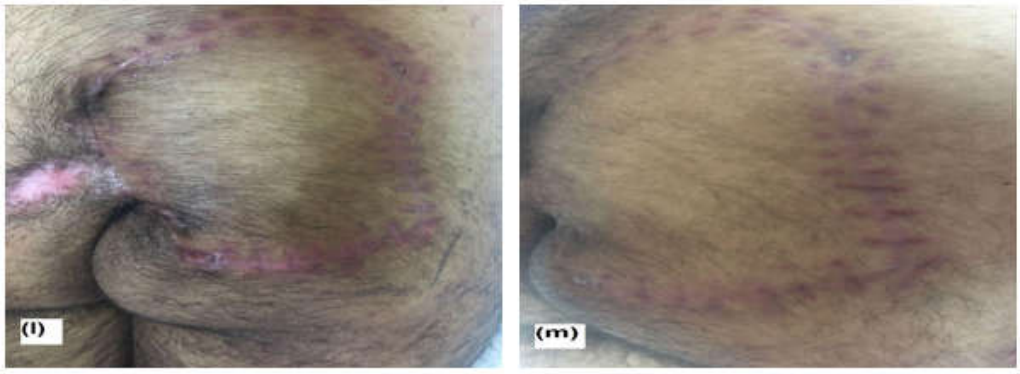


Figure no (5) : (i&j) after final closure of flab and drain insertion (k) one week post. Op.



: (l&m) after 6 months post. Operative

RESULTS:

Eleven patients presented to us with soft tissue defect in anterior upper leg (2 patients), lower leg (1 patient) calcaneum (1patient) and in sacral region (5 patients) and ischial region (2 patients). Our patient age was ranging between 25-60 year (all of them are male). The width of the defect was ranging from 3cm to 10 cm. we used type IIA keystone flap in 9 patients, and in two patient (calcaneum and sacral defect) we used omega variant of flap. 10 out of 11 patient showed complete flap survival with no necrosis or wound dehiscence, with adequate coverage of the defect site with acceptable aesthetic appearance only one of our patients (patient No.2) had wound dehiscence. This patient was treated with local wound care and management and healed completely without any sequelae.

Also, one patient case no.9 has develop hematoma after one week of surgery. Fortunately, hematoma have been evacuated promptly without effect on flap viability and survival.

Minimal postoperative pain and was observed in our patient , sensation return in flap was observed in 3 of our patient (traumatic) during follow up period. While remaining were paraplegic patients due to spinal cord injury.

Follow up for 6 months, in pressure sore patients we extend our follow-up period up to one year to evaluate versatility and durability of flap and to assess if any recurrence had occurred, our follow-up shows promising results with no one developed recurrence of their ulcer in spite of they were bed ridden patient due to spinal cord injury.

Figure 6 :case NO. 1
(a) 55 years old paraplegic patient with sacral pressure ulcer measuring 4*6 cm
(b) after wound excision
(c) incision and advancement of flap
(d) after final closure of defect and flap
(g&f) 1 year after surgery

Figure no (7) : case no. (3); (a) 35 years old male, a victim of blast injury with 4 * 6 cm calcaneal soft tissue defect. (b) marking of omega variant (two opposing keystone flab plus rotation), (c&d) six months post. Operative show complete wound healing .

DISCUSSION:

Since keystone flap introduction by Behan in 2003, this flap has proven its versatility as reconstructive option of soft tissue defect in various location of the body. Keystone flap is fascia – based island flap that supported by the subcutaneous vascular network including fascial and muscular perforators (11) .

In this series keystone Perforator Island flap provided good coverage same color and texture of surrounded tissue thus it reduced donor site morbidity and provide patient with acceptable aesthetic appearance. It also avoids using skin graft in area where the skin graft is needed, since graft lead to donor site morbidity, also it increase time of hospitalization with significant cost to the health system. Need no Doppler whether preoperative or intraoperative planning and harvest.

keystone perforator island flap had been used for surgically treated soft tissue defect in various part of the body (4 cases in lower leg) and (7cases in sacral and ischial region).

The flaps were chosen in area of the maximum skin laxity, and raised parallel to the long axis of cutaneous dermatome whenever it is possible so this will enhance the possibility and increase flap survival since it includes within it neurovascular structure which is incorporated into the flap. Not all of used flap were placed over named cutaneous dermatome in such case, it can be place over muscle bellies wherever possible in order to improve incorporation of the perforators and flap movement during closure [٧] .

The types of the keystone flap used in this study was IIA in 9 cases and in two case we used omega variant type. Type IIA keystone flap used in this study since the defect was more than 2cm (the defect size was varying from 3 to 10cm). when defect more than 2cm , the keystone flap cannot mobilize to close the defect without tension on donor site, so in such case we need to do fasciotomy around the flap which will decrease the tension without jeopardize its blood supply since it depend i.e. keystone flap on its underlying perforator that incorporated within it.

We encountered one case of wound dehiscence of this type i.e. type IIA. In this case no.2 we followed up patient and the dehiscence closed by local wound care and management without need for revisional surgery.

In two cases we used omega variant of keystone flap, first patient case no.(3) had exposed calcaneum bone , in which low tissue laxity in this area so we need to do two opposing keystone flap with undermining and rotation of one end of flap done to close the defect without affected the blood supply of the flap and the flap survive without any complication .and other case no.(9) also have large sacral pressure sore (7 X 10 cm.) we use type III keystone flap (2 opposing flap) while intraoperatively we faced decrease tissue laxity so we change the flaps into type IV (omega variant) to allow closure without affecting the blood supply of flap and flap heal without any sequel.

Our results are in general consistence with sudjatmiko et.al [٩] . Were they used keystone flap in nine case of various locations of soft tissue loss, their results showed that out of 9 defects, all flap survived completely without problem of vascularization. In the above mentioned study , they use doppler to identified the perforator in 2 cases , while in our study we didn't need to identified the perforator by doppler, we just planned it along cutaneous dermatome , or when it not possible along the assumed perforator along muscle bellies.

Also, our study is consistence with P et.al [١٠], were keystone flap was used in 15 patient in various locations of the body following tumor excision or posttraumatic, in this study, type I used in (nine case), type IIA (four case), type III (one case), and type IV (one case). Their results showed that all the flap survived without any even partial necrosis, regardless of the site and the type of keystone which was used and the aesthetic outcome was quite satisfactory, as the flap aligned without evidence of pin cushioning appearance which sometime seen around island reconstruction. The same results were achieved in our study but with larger defect and in chronic wounds.

There were no one apply it on pressure ulcer apart from Hwan Byun et.al [١٢] in 2016 in which case report of single case of the use of keystone flap in greater trochanteric pressure sore, also he used computed tomography angiography for the patient and Doppler allocation of perforators, while in our series, we operate seven patients with pressure ulcers (sacral and ischial) and we don't need to do Doppler allocation of perforators and depend on dermatomal segment to design the flap and capture the perforators. The v-y advancement after islanding at the both end of keystone flap creates a redundancy that can be used to close defect. Closure the v-y defect at each side will narrow the defect so the flap does not need to move so far horizontally. Similarly, the secondary defect on the opposite site of the flap is reduced so it can be closed directly without skin graft (of course apart from type IIB). Suturing the angles in v-y fashion also locks the flap into its definitive position [١٢] .

Keystone flap has both autonomic and somatic innervation. In spite of tension line that occur during the closure of the flap, this not affected the vascularity of the flap ,in contrast , keystone flap appears more erythematous and hyperemia than surrounding tissue which may exist for long period of time in some patients. This can be explained to be result from autonomic and somatic afferent denervation which lead to vasodilation and loss of vasomotor tone of blood vessels due to complete islanding of flap and this is usually consistent with S.H Milton in 1971 as he found that complete island safer than peninsula.[13]

CONCLUSION AND RECOMMENDATION:

Keystone flap is relatively easy to learn and form, which provided excellent and versatile coverage for soft tissue defect in various part of the body, with little post-surgical care comparative to other sophisticated approach such as free flap.

We recommend to use this keystone island perforator flap in closure of pressure ulcers and traumatic soft tissue defect in candidate patients, in which there is available surrounding tissue to apply the flap.

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