

Our Experience with Key Stone Design Island Flaps Applied Over Wide Variety of Defects

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Abstract

Original Research Article

Reconstruction of tissue defects with a similar (in terms of colour, texture, hair), simple, reliable and stable tissues remains a challenge in reconstructive surgery. Unless local surrounding tissue is used to cover the defect by a technique or method, this challenge is not fulfilled. Keystone flap are based on the three-dimensional vascular architecture of the skin and soft tissue overlying the bones so called angiosomes and perforasomes. This surgical technique applied in 36 cases is simple, versatile and with good aesthetic outcome. The aim of this study is to delineate the versatility of keystone design flaps in the reconstruction of various soft tissue defects. This is a retrospective study done for 3 years (January 2016 to January 2019) for 36 patients who underwent Keystone flaps for various defects. The age of the patients ranged from 6 to 82years. Of the 36 defects, 14 were done to reconstruct post traumatic raw areas and post infective raw areas, 12 were following excision of skin tumors, 4 done for post burn defects, 3 done for closure of donor defects, 2 done for scar revision and 1 for melanocytic naevi excision. Most of the flaps were applied in head and neck region. Only one Keystone flap done for post traumatic defect had partial flap necrosis. The keystone design flap is a versatile reconstructive option for various defects which is simple, easily reproducible, performed within a short duration, with high success rate, using surrounding local tissue to move over the defect and restore normalcy and has minimum complications.

Keywords: Keystone flap, Defect, Reconstruction, Perforator.

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INTRODUCTION

There are many options for the closure of wounds in the armamentarium of Plastic Surgery. Closure of defects using local flaps depends on the visco elastic properties of the skin. The keystone design perforator island flap (KDPIF) was first described by Behan as a trapezoidal shaped flap that is essentially, two conjoined v-y island flaps, in 2003 [1-4]. The vascular supply is supported by the subcutaneous vascular network and is dependent on facial and muscular perforators [5]. Four types are described. In the classical technique, very limited elevation of the flap from its bed is performed. Perforators from the bed of the flap are presumed, but never identified. Keystone flaps have come up as the chief local option for reconstruction of various defects over the trunk [6]. A keystone-design perforator-based flap is based on a synthesis of well-established concepts. It provides a solution for performing a local flap in a difficult region such as the leg, where lax and mobile skin is at a premium [7].

The keystone island flap offers both robust vascularity of perforator flaps and relative ease and speed of local tissue rearrangement. Other advantages of this technique include short operative time, high reproducibility, ease of use and local tissue aesthetic similarities. Microsurgical perforator flaps are useful but owing to their technical complexity, steep learning curve, prolonged operating time may limit their adoption. This paper aims to determine the versatility and safety of keystone design perforator flaps in reconstructing various defects.

MATERIALS AND METHODS

The present study was conducted at Government General Hospital, Siddhartha medical college, Vijayawada, Andhra Pradesh in the Department of Plastic Surgery for a period of three years from January 2016 to January 2019; Total 36 patients in the age range of 6-82yrs were operated upon for skin defects in various locations which include head and neck, trunk, and limbs. Patient demographic data, medical history, co morbidity, potential risk factors,

surgical indication, defect features, complications, outcome and follow up are evaluated and presented as an uncontrolled case series. Informed consent and permission for usage of photographic data was obtained from all patients

Exclusion criteria

Patients with extensive crush injuries were excluded in this study.

Operative technique

The defect is considered as an ellipse for flap planning. Factors involved in flap planning are laxity of local skin, dermatomal territory, and distribution of Dopplered perforators especially in extremities. The ellipse should lie parallel to the lines of cutaneous nerves, veins and or cutaneous perforators. The Keystone has a ratio of 1:1 for the width of defect to the width of the flap. The length of the flap is determined by the size of the excisional defect. A right angle is created at the limits of the excision to create the keystone. The side of the defect that has the greatest laxity is chosen for the donor flap site. No dissection is done beneath the island flap to prevent injury to the fascio cutaneous or musculo cutaneous perforators. Our modification: The angle at the edge of the defect was customised according to the size of the defect and surrounding laxity. In type II and type III key stone designs, fascia is not incised on all three sides. A maximum of two sides are incised preserving the fascia adjacent to the defect intact for better vascularisation.

RESULTS

A total number of 36 patients with soft tissue defects, reconstructed with keystone flaps were studied. Among these 36 patients, 26 were males and 10 were females with a male to female ratio of 2.8:1. Age of the patients ranged from 6 to 82 years. The oldest was 82 year old with basal cell carcinoma in the forehead region. Bilateral keystone flaps were done (Fig 1A-D). The youngest in the study was a 6 year old boy with post infective raw areas on either side of the knee (Fig 2A-2C). The size of the defect ranged from 2×1cm² done for finger tip defect (Fig 3A-3C) to 25×10cm² flap done for the closure of donor defect of the thoracoabdominal region of the pedicled flap used to cover a posttraumatic forearm defect (Fig 4A -4D). Of the 36 defects, 14 were done to reconstruct post traumatic raw areas and post infective raw areas, 12 were following excision of skin tumors, 4 done for post burn defects, 3 done for closure of donor defects, 2 done for scar revision and 1 for melanocytic naevi excision.

Site of Keystone flap: 16 flaps were done in head and neck region, 14 in upper and lower limbs and 6 in the trunk. 14 key stone flaps were done to cover lower limb defects, 4 flaps were done for upper limb defects (20%) and the remaining 2 were for axillary defects in open proximal humerus fracture (10%) (Chart-2). We have done 25 cases with type I Behans flap, 4 with type II, 3 with type III and 2 with type IV Behans flaps along with our modification (Chart-3).

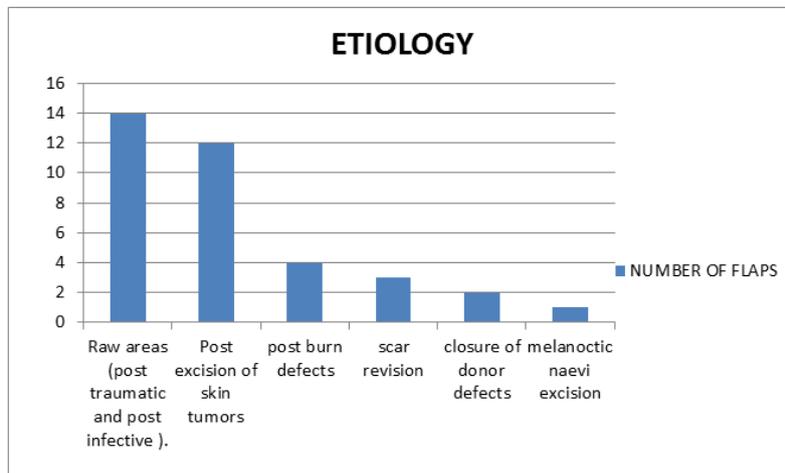


Chart-1: Etiology Vs Number of Laps

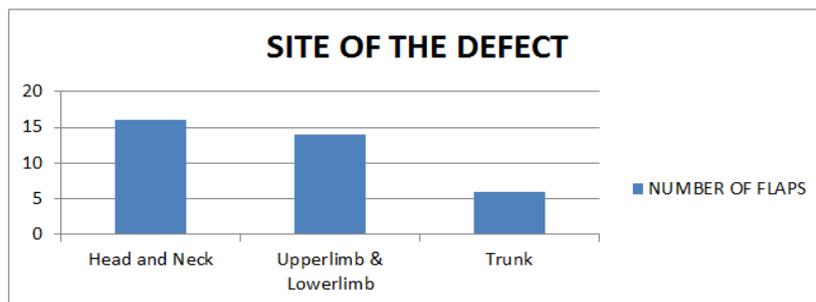


Chart-2: Site of the defect Vs Number of Laps

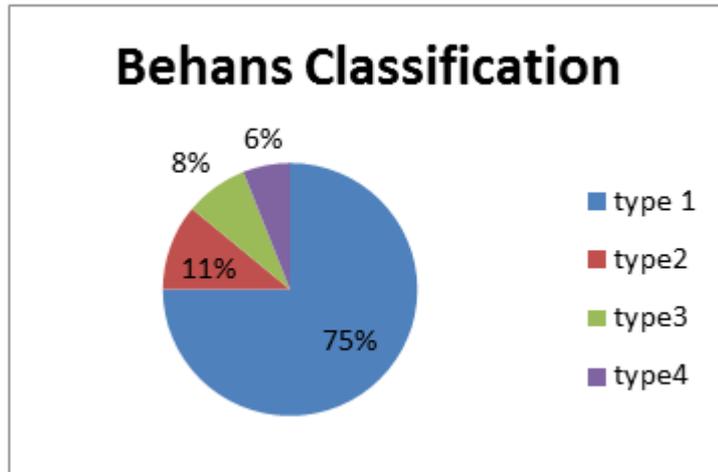


Chart-3: Behans Classification



Fig-1A, 1B, &1C: Photograph of the oldest women in our series with Basal cell carcinoma over forehead Reconstruction with bilateral keystone flaps



Fig-2A, 2B &2C: Photograph of the youngest patient in our series, a six year old boy with a post traumatic defect over the knee



Fig-3A, 3B&3C: Photograph of Smallest keystone flap done over the fingertip



Fig-4A & 4B: Photograph of the largest keystone flap done to cover the donor defect of a thoracoabdominal pedicled flap to cover forearm defect



Fig-5A, 5B&5C: Photograph of Post traumatic raw area exposing the iliac bone



Fig-6A, 6B &6C: Photograph of Post electric burn defect over neck exposing mastoid



Fig-7A, 7B &7C: Photograph of Recurrent Dermatofibroma, wide excision and reconstruction with keystone flap with good aesthetic outcome



Fig-8A, 8B &8C: Photograph of basal cell carcinoma, wide excision and reconstruction with keystone flap with good aesthetic outcome



Fig 9A, 9B &9C: Photograph of post traumatic raw area, reconstruction with keystone flap

The average intra-operative time required to complete the flap was 45 minutes (range 20-90 minutes). The average hospital stay was 5 days. All subjects were followed until they achieved a stable, healed wound. Complications were, partial flap necrosis was observed in one case which required skin grafting (5 percent). The overall success rate was 95 percent.

DISCUSSION

According to Felix Behan - to design a flap the same width as the primary defect, immediately adjacent to it, that has essentially the same mobility characters and to expect it to not only close the original defect as well as its own large secondary defect seems empirically daring'. The vascular safety of the KDPIF is beyond all doubt; it is the design of this flap that apparently allows the rules of length and breadth ratio to be overruled, by optimum use of biophysical properties of skin [8].

Our study on 36 keystone flaps has shown that, they are a versatile tool in the armamentarium of plastic surgery. Skin graft done for the same defects gives unstable cover and inferior cosmetic appearance. Transposition flaps can cause contour deformity over the flap and hyper pigmentation of the skin grafted donor area. Local transposition flaps may result in partial flap necrosis. This technique can reduce the need to perform microsurgical flaps which require significant operating time, healthy recipient vessels, prolonged hospital stay that usually require intensive care for flap monitoring. Keystone flap requires shorter learning

curve when compared to perforator flaps and micro vascular free flaps.

Advantages are:(a) Replacement of like with like, (b) absence of dog ear, (c) preservation of multiple perforators ensuring flap survival, (d) usage of the best flap design for local tissue recruitment, and (e) potential for primary closure of even the secondary defect (f) preservation of reconstructive life boats⁹. Our modification in type II and type III key stone designs includes, fascia not being incised on all three sides. A maximum of two sides are incised preserving the fascia adjacent to the defect intact for better vascularisation. In our experience large defects over the trunk, gluteal region and thighs could be easily covered with keystone flaps due to skin laxity, whereas small to moderate sized defects over head and neck ,upper extremities and legs could be covered with ease to do limited laxity. Our results are comparable with other studies in terms of adequate stable cover, viability and good aesthetic outcome. This flap can be a useful tool in wound closure for soft tissue defects. However, key stone flaps have minor drawbacks like long scars beyond the limits of the defect and its arc of rotation is limited. Our results are consistent with studies by Satish p bhat and Aravind on keystone flaps [9, 10] however there only a few studies on keystone flaps done over wide variety of defects at different sites of the body.

CONCLUSION

Keystone flaps are a versatile tool in reconstructive surgery. They can be applied to variety

of defects obviating the need for microsurgical techniques. Primary wound healing can be achieved with good aesthetic outcome and no donor morbidity. Key stone flaps have 97% success rate compared to other reconstructive options. The technique described in the present study offers a simple and effective method of wound closure in situations that would otherwise have required complex flap closure or skin grafting.

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