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Experimental study on axial pedicled composite flap prefabrication with high density porous polyethylene implants: medporocutaneous flap☆

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Summary Composite flaps including soft tissues with bone or cartilage are widely used in reconstruction of three-dimensional defects, but have some disadvantages. Flap prefabrication with alloplastic implants is an alternative procedure. Axial pattern vascularised high density porous polyethylene (HDPP) implants are capable of sustaining skin grafts. The purpose of this study was to examine the vascularisation pattern of the skin island in a composite flap prefabrication model prepared with vascularised HDPP implants. Forty male Wistar rats divided into four groups were used. A 9.5 × 6 × 2 mm HDPP block was centered on the dissected saphenous pedicle and anchored under the abdominal skin in the experimental group I ($n = 10$). In experimental group II ($n = 10$) saphenous artery and vein were put between the skin and the implant. Thus, the structures were laid as skin, HDPP block, pedicle in experimental group I and skin, pedicle, HDPP block in experimental group II. HDPP block-implanted and pedicle-implanted only groups served as control groups I and II, respectively. Eight weeks after prefabrication, skin islands 1.5 × 5 cm in size incorporated with implants were elevated based on saphenous vessels in the experimental groups and skin islands only based on the pedicle in control group II. Skin islands of the same dimensions were raised as grafts in control group I. Nylon sheets were put under the flaps and grafts to prevent vascularisation from the recipient bed. Flap viability was assessed by measuring the surface area on the 7th day. Total necrosis developed in composite grafts of control group I. Flap survival was higher in experimental group II and control group II (45% and 46.8%) than in group I (29.28%). Histologic studies demonstrated fibrovascular ingrowth into the HDPP implants, except in control group I, with significant inflammatory response and necrosis. Vascularisation of skin and implants from the pedicle was

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seen also microangiographically. In conclusion, a composite flap prefabrication model including vascularised HDPP implant, skin and vascular carrier was developed. This new flap was termed a 'medporocutaneous flap'.

In the reconstruction of three-dimensional defects, soft and hard tissues must both be replaced to achieve optimal form and function. Avascular autogenous bone and cartilage grafts, vascularised bone grafts or composite flaps can be used for this purpose. Limited availability of donor sites, more complicated surgery requirements, reshaping difficulties and resorption of avascular grafts are the disadvantages of autogenous tissues.[1,2]

Currently, alloplastic implants, which avoid the problems mentioned above, are preferred, but adequate vascularity and soft-tissue coverage are emphasised for permanency of the implant in the recipient bed. Sometimes these conditions can not be established as a result of previous surgeries or irradiation. Thus, implants may be inoculated or infected secondarily.[3] This problem has been solved in previous studies by vascularising the porous implants before transferring into the recipient bed.[4–14] Some authors reported that porous implants can sustain skin grafts after prefabrication using a vascular induction technique.[5–8,10,11,13,14] Others transferred vascularised porous implants as parts of composite flaps.[4,9,12] This study offers a new experimental model in which skin and a porous implant (i.e. high density porous polyethylene, HDPP) are prefabricated with a distant vascular source simultaneously. The aim was also to determine the optimum position of the pedicle with regard to target tissues (i.e. between or under) to create a larger vascular skin territory. This experimental model can be applied clinically in the reconstruction of cranial defects with soft-tissue deficiency or other three-dimensional defects such as nose, ear and hard palate.

Materials and methods

All experiments were conducted according to the rules of the local ethical commitee. Forty male Sprague–Dawley rats weighing 350–400 g were used for the study. All rats were housed in seperate cages exposed on a day and night cycle, and received standard food and water *ad libitum* during the experiments.

Before surgery $6 \times 9.5 \times 2$-mm rectangular HDPP blocks were cut and prepared from a $38 \times 63 \times 9.5$ mm HDPP block (Medpor®, Porex Surgical Inc., College park, GA, USA). All blocks were then sterilised by ethylene oxide gas (Fig. 1).

Rats were equally divided into two experimental and two control groups as specified in Fig. 2. In experimental group I (EG-I), vascular pedicle was placed between the skin and HDPP implant, and under them in experimental group II (EG-II). In the control group I (CG-I), HDPP implants were simply buried under the skin. Conventional skin flaps were prefabricated by using a vascular induction technique in control group II (CG-II).

Surgical procedures

Sodium thiopenthal (30–50 mg/kg) anaesthesia was administered intraperitoneally before all surgical procedures. Regarding the concept of flap prefabrication, the experiment was designed in two stages.[15] An 8-week time interval was allowed between two stages for vascular integration. An additional third stage was performed by killing the animals 1 week after the second stage to obtain samples for macroscopic, histologic (i.e. light and electron microscopy) and microangiographic evaluations.

In the first stage, the right thigh and right lower abdomen were depilated with a cream and prepared with povidon iodine solution. A vertical incision on the medial side of the right thigh was made from the inguinal ligament down to the knee of the animal. The right saphenous artery and vein including the femoral nerve were dissected as a bundle, ligated and divided distally. A subcutaneous pocket 15×15 mm in size was prepared under the abdominal skin parallel to the inguinal crease. Epigastric vessels were ligated and cut so as not to interfere at the second stage. A HDPP block $9.5 \times 6 \times 2$ mm in size was fixed to the end of the pedicle by 7-0 prolene so that pedicle would center the long side of the implant. The implant–pedicle complex was then turned over and inserted through the pocket according to the designed positions of EG-I and II as described above. So the saphenous pedicle was implanted *between* the skin and HDPP implant in EG-I and *under* them in EG-II. The tip of the pedicle was also secured percutaneously to avoid

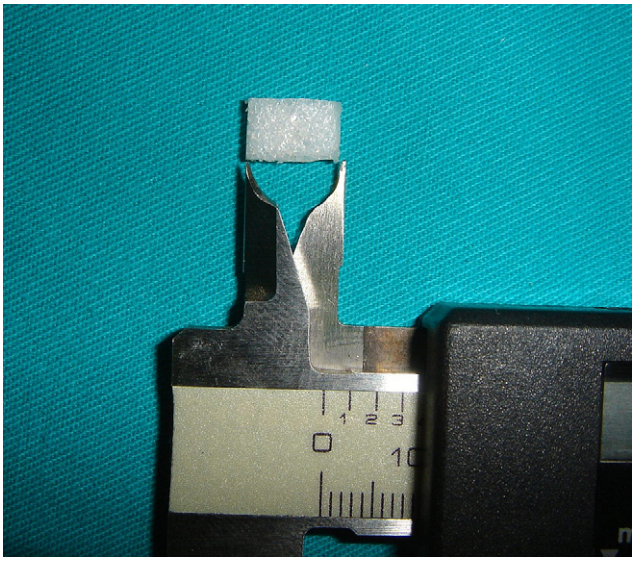

Figure 1 A $6 \times 9.5 \times 2$ mm block of high density porous polyethylene.