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Gluteal propeller flaps - A reliable reconstructive alternative for elderly patients with pressure ulcers of the sacrum

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1. Introduction

Pressure ulcers are common problems especially in elderly patients with immobility and inactivity due to significant co-morbidities such as diabetes and arterial vascular disease [1]. In general, apart from restricted mobility a lack of balanced nutritional conditions and insufficient health care (missing physiotherapy, unmodified patient positioning, suboptimal use of pressure ulcer preventing devices e.g.) are known as important predictors for pressure ulcers [2–4].

In case of pressure ulcers an elaborate wound care is needed. Since small and superficial pressure ulcers may heal under conservative wound therapy and consequent weight relief, large deep ulcers with exposed bones and joints (stage IV- EPUAP classification) - especially in the sacral region - often deteriorate without surgical debridement. Furthermore, the risk of bone infections and sepsis increases and unpleasant olfaction and insufficient and painful conservative attempts may aggravate patient isolation and reduce overall survival [5].

Wound healing after surgery is proposed to be much quicker. According to current guidelines, infection of soft and bone tissue should be diagnosed early and treated sufficiently prior to any reconstructive attempts [5,6]. Operative treatment should include radical surgical debridement followed by sustainable soft tissue reconstruction to ensure long-term wound closure. Wound healing itself decreases loss of proteins and fluids and reduces the possibility of wound infection, and the development of wound malignancies [6].

Multiple reconstructive options for wound closure and various modifications has been described, such as bilateral rotational or VY-flaps [7], modified advancement flaps [8], perforator flaps [9,10] and in rare situations even free flaps [11]. Indications for conventional random-pattern flaps such as rotational or transposition flaps are considerably limited; limited flap dimension due to preexisting scars in case of recurrence and the risk of severe perfusion problems significantly increases. Moreover, due to their limited arc of rotation, traditional rotational flaps tend to have their weakest point of both, perfusion and mechanical stress to the wound margins, in close proximity to the anus. In consequence, partial flap loss predictably leads to full thickness wound healing problems in such delicate areas.

Perforator flaps may be used as alternatives. These techniques are described for sacral pressure ulcer reconstruction as well [9,10]. The rotation of up to 180° degrees allows a high flexibility in flap positioning. This flexibility in flap inset is unmatched by any other reconstructive method. This technique enables an abundancy of healthy tissue from a distant, unscathed area to be placed into the defect without any tension [12].

In the present retrospective study, we describe our experiences for the treatment of severe sacral pressure ulcers in elderly patients with multiple co-morbidities, especially for those who were admitted to our hospital for revision surgery of the sacrum. In addition, we outline the histopathological and microbiological findings and we will propose a standardized therapeutic approach to these critical ill patients.

2. Material and methods

In this analysis, retrospective data from 17 patients (eight males and nine females) was included, who underwent pedicled perforator flap surgery between February 2017 and June 2018 in our hospital. Standardized recorded data was assessed using patients' charts.

Including criteria were infected, deep pressure ulcers (stage IV-EPUAP classification) of the sacral region. Prior to surgery patients were assessed for their nutritive status (body-mass-index, albumin, zinc, vitamin c) and if needed, amelioration was achieved by nutritive support. Patients with proved severe malnutrition or dramatically impaired general health condition were excluded for any reconstructive attempt. Patients were *not* excluded for reconstructive surgery due to age or severe co-morbidities, such as diabetes or coronary/peripheral vascular diseases when anesthesiologic approval was confirmed. Patient agreement or written informed consent of relatives or legal supervisors based on a comprehensive disclosure were mandatory for surgery.

Prior to any surgery microbiological wound samples were taken. Patients received a minimum of two subsequent radical debridements and temporary vacuum assisted wound therapy. In case of altered bones, histopathologic bone samples were obtained. In case of positive

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proof of osteomyelitis, radical osseous re-debridement was initiated before wound closure.

Patients with wounds in close proximity to the anus (< 3 cm) underwent stoma surgery by the general surgery department after initial debridement. Soft tissue reconstruction was performed at least five days after stoma application.

2.1. Surgery technique

Perforators (S-GAP, I-GAP) were outlined and marked using a handheld doppler. In case of previous operations in the gluteal region, perforators in unaffected skin areas were detected. Dissection was performed under loupe magnification and started at the wound margin. Perforators were identified without any further skin incisions if possible. Flaps were generously sized in relation to the defect to ensure sufficient soft tissue replacement. In some cases cranial skin incision according to marked flap dimensions was necessary. Under these circumstances only limited incision was performed to enable traditional rotation flap when perforators were deemed insufficient after preparation. Perforator preparation was continued until a pedicle length of 5–7 cm was achieved to avoid kinking or torsion of the pedicle after flap rotation. When a sufficient perforator was properly exposed, skin incisions were completed and the flap was checked for venous congestion or perfusion problems assessing capillary refill time and brisk capillary bleeding of the flap margins. Then the flap was rotated into the sacral defect. Donor sites were closed primarily (Fig. 1a, 1b, 1c).

Some patients additionally received preventive vacuum assisted closure therapy for five days to minimize tension of wound margins and to optimize absorption of wound fluids. Drains were placed under the flap and at the donor site. Postoperatively, patients were placed in an air-fluidized bed (Citadel, ArjoHuntleigh 2015) in a lateral decubitus position to minimize pressure on the operated area for seven days. Concomitant antibiotic therapy according to resistance proofs was given for ten days. In case of proved osteitis, oral antibiotic treatment was continued for six weeks postoperatively. Patients were mobilized after seven days and were able to sit without restrictions in bed or wheelchair after removal of suture material on day 21 postoperatively (Fig. 2).

3. Results

3.1. Patients

The mean age of patients was 74.1 years (51-88 years). Sixteen out of 17 patients were bedridden and had neurological diseases (94.1%), most of them were common vascular dementia (eight out of 17). Other neurological disorders were Parkinson (n = 2), multiple sclerosis (n = 1), Guillain-Barré-Syndrome (n = 1) and spinal cord injuries (n = 2). Thirteen out of 17 patients were not able to express their wishes and were under legal supervision. BMI had been in average

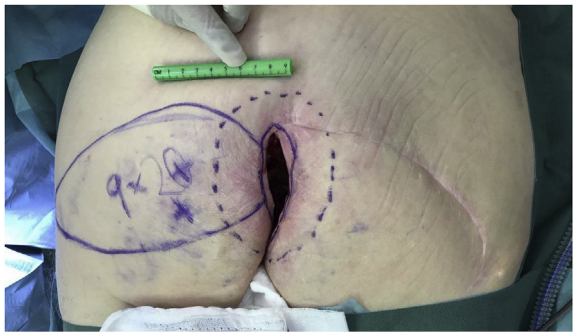

Fig. 1a. Flap design on the left (revision surgery with previous rotational flap on the right). The dashed-line marks the size of the wound.

Fig. 1b. Postoperative result. Dead space could be avoided.

Fig. 1c. Follow-Up (22 months).

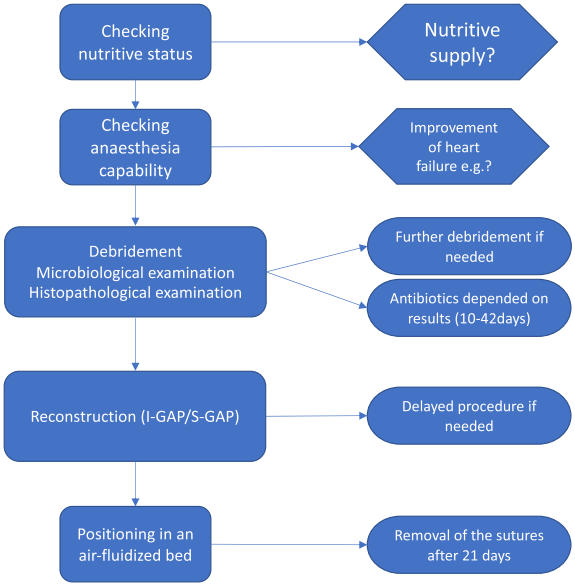

Fig. 2. Treatment survey.

27.1 kg/m^2. None of the patients showed severe hypoalbuminemia or hypoproteinemia in blood samples. Diabetes and coronary or peripheral vascular diseases were found in ten patients (58.8%). Ten out of 17 patients had previous reconstructive operations in the gluteal region (58.8%, none of them were previously treated with propeller flaps). Mean hospital stay was 37.9 days (21-74 days). Average follow-up was nine months, ranged from two up to 22 months after hospital discharge.

3.2. Defects

All patients had infected full thickness sacral pressure ulcers due to impaired mobility. One patient received soft tissue reconstruction due

Fig. 3a. Venous congestion.
Flap had been rotated back and sacral wound defect was covered by vacuum therapy.

to an unstable ulcer following severe gluteal basalioma (incidental finding). Wound size before debridement averaged 52.8 cm^2. Four patients (23.5%) received stoma operation prior to flap reconstruction (defects closer than 3 cm to the anus).

Microbiology: In 14 out of 17 patients (82.4%) there have been more than two bacterial stems. Most common bacterium had been *Escherichia coli* and *Proteus mirabilis* (each 14.8%), *Enterococcus faecalis* (11.48%) and *Staphylococcus aureus* (8.2%). In one patient we detected MRSA, VRE and 4-MRGN.

Histopathologic results: All patients with exposed sacrum received debridement and bone samples were taken. In twelve out of 17 patients (70.6%) osteomyelitis was confirmed by a specialized pathologist.

3.3. Operative procedures

Patients received an average of three subsequent debridements before soft tissue reconstruction. After flap surgery, six patients (35.3%) needed further operations for secondary wound closure, re-debridement due to wound healing problems or delayed procedure because of intraoperative venous congestion (Fig. 3a, 3b).

Eleven out of 17 patients did not require any further operation after flap surgery (64.7%).

Fifteen patients (88.2%) received S-GAP propeller flaps, whereby one patient had bilateral S-GAP flaps due to the enormous wound size. Two patients were treated with I-GAP propeller flaps. No complete flap loss was detected. The average size of propeller flaps had been 183.8 cm^2. Median of flap operation time was 158.9 min (106-240 min).

3.4. Complications

Two patients (11.8%) had severe coronary complications postoperatively with heart failure and deceased later on during hospital stay. Four patients (23.5%) showed minor complications such as partial wound healing impairment, distal flap necrosis (under 10% of total flap area). Two of them had previous operations in gluteal regions with rotational flap attempts.

In two cases (11.8%) rotation of completely raised propeller flaps were delayed (four days after flap harvesting) due to intraoperative venous congestion. All cases healed after secondary wound closure. Two patients died after leaving the hospital due to heart failure (two and five months after discharge, respectively).

Fig. 3b. Delayed procedure (4 days after re-rotation and resection of partial necrosis).

4. Discussion

Treatment of sacral pressure ulcers remain a challenging problem for reconstructive surgeons. Various factors affect wound healing and therefore patient prognosis. Correct identification of patients who are suitable for any reconstructive attempt with convincing prognosis for stable wound closure turned out to be challenging and difficult as well.

Bad nutritional status is one of the main factors for wound healing disturbances [2,3,13] and should be treated prior to any reconstructive attempts; a sufficient nutritive balance and optimized patient care concerning co-morbidities play an important role in successful treatment of recalcitrant wounds. Furthermore, patient outcome is dependent on other factors such as co-morbidities, patient compliance and postoperative rehabilitation. In accordance to these findings indications for soft tissue reconstruction should be strictly checked and clear treatment protocols should be obtained. Peri-operative risk due to prolonged and repetitive general anesthesia must be valued with the benefit of sustainable wound closure and minimized risk of sepsis or wound deteriorating [5]. Benefits of sufficiently closed wounds with low rates of pressure ulcer recurrence are evident foremost in elderly and bedridden patients. Although daily wound cleaning in the ambulatory setting are challenging endeavors for patients and care-givers. Chronic sacral pressure ulcers remain susceptible to various infections with permanent risk of severe sepsis. Moreover, chronic pressure ulcers are significant financial burdens for any health care system [14]. We endorse the aim of sustainably closed wounds being superior to open wound treatment in elderly patients. Healing time is quicker, rate of re-wound infections declines, painful wound cleaning could be avoided and long-term treatment costs may be lower [5].

Reconstructive attempts to address sacral pressure ulcers are manifold. Most commonly used are local flaps, such as rotational, advancement or VY-flaps, which have been demonstrated to show similar outcomes in wound closure and long-term prognoses [7,15]. Using perforator based- or freestyle propeller flaps for reconstruction of sacral pressure ulcers showed promising results as well [9,10,12]. Indeed, others demonstrated that propeller flaps used in this entity showed convincing success rates and low morbidity [16]. The presented study may underline these findings with reliably closed wounds in 88.2% of cases, although several patients needed limited secondary wound suture and two patients (11.8%) departed during hospital stay postoperatively.

Basically, the gluteal region shows a high number of suitable perforators [17]. In consequence, perforator flaps are applicable in a huge variety of clinical situations, even in pre-operated regions.

Dreaded complication in perforator flap surgery is a total or partial flap loss due to venous congestions. In our patients we found two cases with signs of immediate venous congestion intra-operatively. In both cases complete flap recovery was ensured when flap inset was delayed to a secondary approach four days later. We totally agree with others that indication of delayed flap inset should be strict in any case with intraoperative evidence of venous congestions [18]. As described before, the rotational angle in propeller flaps always should be minimized and pedicle length should be sufficiently exposed (minimum 5–7 cm) to avoid torsion or kinking foremost of the concomitant veins [19].

Comparisons of perforator flaps and traditional techniques (rotational or VY-flaps) are rare. Fujioka et al. described a significantly higher rate of postoperative complications and a significant higher rate

of postoperative seroma formation in patients who underwent rotational flap surgery compared to patients who received perforator flaps [20]. In our opinion, the major advantage using perforator-based flaps is the significantly improved flexibility of flap inset in the region of interest. Furthermore, healthy and unscathed tissue may be placed into the area where needed most [12]. A reliable und sustainable amount of subcutaneous soft tissue may be used to fill in even deep full thickness defects with well perfused unscathed flap portions. Dead space can be avoided effectively and early complications such as venous congestions can be identified easily intra-operatively and may be treated with delayed flap rotation. Moreover, muscles are spared and wound enlargement due to flap harvest can be minimized, so muscle flaps may be saved as a secondary approach in case of pressure ulcer recurrence [12].

Limitations of the study: Presented data was assessed by retrospective investigation with limited sample size due to occasional cases. Patient cohort is heterogeneous due to different wound sizes and geometry, general health conditions and clinical situations (co-morbidities, age e.g.).

The present study demonstrates that elderly patients with severe comorbidities (diabetes and arterial vascular diseases) may show sustainably closed wounds using perforator-based propeller flaps even when severe and huge pressure ulcers were treated. Even in patients with severely compromised health status convincing results of soft tissue reconstruction are expectable, although minor complications such as secondary wound closure are higher. In conclusion, propeller flaps may reliably complete the armamentarium of reconstructive approaches in highly demanding cases such as repetitive pressure ulcers of the sacrum.

Ethical standards

This retrospective analysis was approved by the regional ethical committee.

Patient consent

Informed consent has been obtained prior to the use of the photographs.

Declaration of competing interest

None.

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