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Disruption of Skin Perfusion Following Longitudinal Groin Incision for Infrainguinal Bypass Surgery

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Objective: *the objective of our study was to investigate whether such an incision results in a reduction in blood flow, and therefore haemoglobin oxygen saturation, across the wound.*
Design: *microvascular oxygenation was measured with lightguide spectrophotometry in 21 patients undergoing femoro-popliteal or femorodistal bypass procedures. A series of measurements were made in the groin, medial and lateral to the surface marking of the femoral artery. The mean oxygen saturation on each side was calculated, and the contra-lateral groin was used as a control. The measurements were repeated at 2 and 7 days postop.*
Results: *oxygen saturation in the skin of the operated groins was increased significantly from baseline at 2 days postop (f=25.80, p<0.001) and had begun to return to normal by day 7. The rise was more marked on the lateral side of the wound than on the medial (f=12.32, p<0.001). There was no such difference in the control groins. All wounds healed at 10 days.*
Conclusions: *these results show a significant difference in skin oxygenation between the lateral and medial sides of the groin following longitudinal incision. This may contribute to the relatively high incidence of postoperative infection in these wounds.*

Key Words: Groin; Infrainguinal; Wound infection; Oxygenation; Spectrophotometry.

Introduction

Postoperative infection of a surgical wound can be a serious problem in peripheral vascular reconstruction. The extent of infection can range from superficial cellulitis to suppurative infection with wound dehiscence, sometimes necessitating removal of the graft.[1] As *Staphylococcus aureus* and *S. epidermis* are the organisms most commonly involved,[2] antibiotic prophylaxis and improved surgical technique can be effective in reducing infection rates.

In all types of infrainguinal surgery, a longitudinal incision over the femoral artery exposes this vessel for attachment of the prosthetic or vein graft (Fig. 1). These wounds are the most commonly infected,[3] and an infection rate of over 6% has been reported.[4]

The skin of the groin is supplied mainly from the branches of the femoral artery. The superficial circumflex iliac artery appears to contribute to the majority of blood supply to the groin and, indeed, free groin flaps are raised on a lateral pedicle.[5] A large proportion of the blood flow to the medial aspect of the groin may therefore be supplied from its lateral aspects.

A longitudinal incision may disrupt dermal blood flow across the groin, to the extent that a significant gradient develops across the wound. If so, this may contribute to the relatively high rate of infection and poor healing of these wounds. The aim of this study, therefore, was to determine whether such a gradient does in fact develop.

Materials and Methods

Patients were recruited from elective admissions to our unit, scheduled for femoropopliteal or femorodistal procedures. Over 8 months, 27 patients were invited to take part in the study, which was approved by the Tayside Committee on Medical Ethics, and all gave informed consent after the protocol had been explained to them. Six of these were excluded for the following reasons: four operations were cancelled, one procedure

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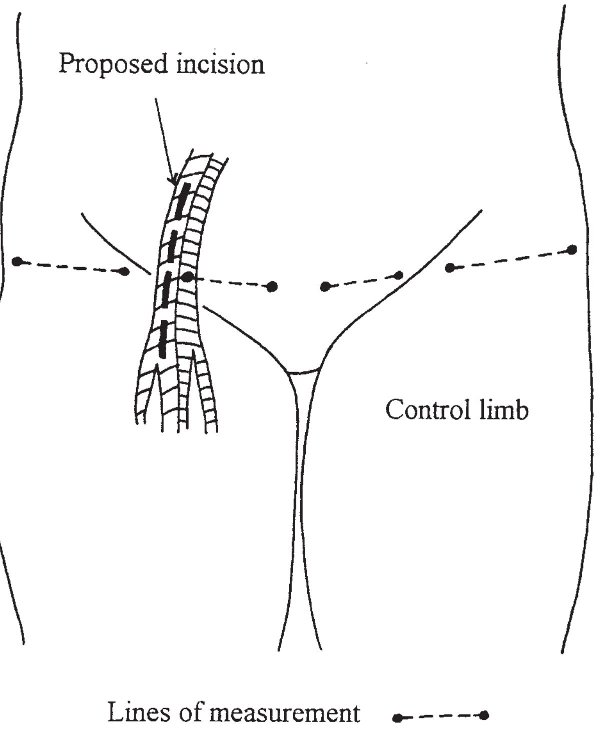

Fig. 1. Diagram showing the position of the proposed groin incision to expose the femoral artery, and the lines of oxygen measurement in each limb.

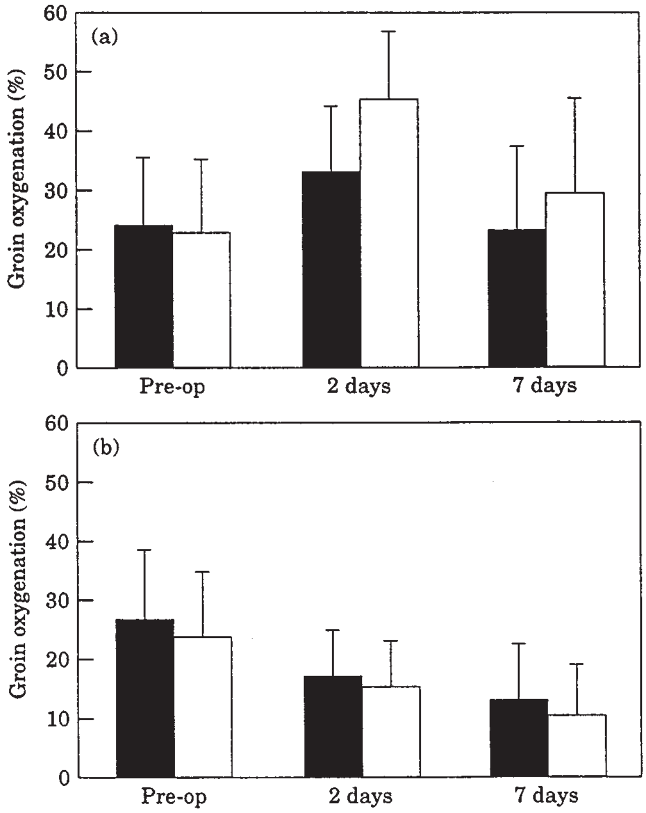

Fig. 2. Skin oxygen saturation on the medial and lateral sides of the groin, before and after infrainguinal bypass surgery, in the operated (a) and control (b) limbs. The height of each column represents the mean value, and the error bars show one standard deviation from the mean. (■) Medial; (□) lateral.

was revised to ileofemoral bypass and was therefore unsuitable, and one patient was non-compliant following surgery.

Of the remaining cohort of 21, there were 12 males and nine females, with a mean age of 72 ± 8. Three were known diabetics and all had a history of tobacco intake (between 5 and 120 pack-years, mean 30), five admitting to being active smokers. All patients had clinically proven peripheral vascular disease, confirmed by Doppler ankle or toe pressure measurement, but no history of iliac disease. Seventeen patients underwent surgery because of disabling claudication (Fontaine IIb), and four had rest pain.

Each patient was initially seen on the day before their surgery. They were rested supine for 15 min in a thermostatically controlled room (21 ± 2 °C). The skin microcirculation in the groin was assessed by measuring haemoglobin oxygen saturation (So_2) using light-guide spectrophotometry (EMPHO II, BGT GmbH, Germany).

In this technique, the relative concentration of oxyhaemoglobin is estimated from the attenuation of visible light (500–620 nm) by the tissue. Optical fibres of 250 μm diameter deliver light to the surface of the skin, and detect that which is remitted. Dedicated computer software analyses the resulting attenuation spectrum to obtain a value of So_2. This parameter is generally lower in absolute terms than might be expected, but correlates well with blood flow changes, and its worth as an index of microvascular oxygenation has been shown in a variety of applications involving peripheral vascular disease.[6–8] The technique was preferable to laser Doppler flowmetry in this situation because of that method's sensitivity to movement artefact.

Baseline measurements were made in the groin preoperatively. At least 50 spectra were recorded on each side of the proposed incision, moving the light-guide smoothly from the mid-inguinal point (surface marking of the common femoral artery) to a point 10 cm lateral; and similarly on the medial side (Fig. 1). The mean So_2 was calculated from each set of recordings.

Control measurements were made in the contralateral groin, and all measurements were repeated at 2 and 7 days postoperation. Statistical differences in the data were tested using analysis of variance for repeated measures. The operated and control groins were considered separately.

Results

In the operated groin, skin So_2 increased significantly from baseline at 2 days postoperation ($f=25.80$, 2 d.f., $p<0.001$), and was returning to normal by day 7 (Fig. 2a). This rise was steeper on the lateral side of the wound ($f=12.32$, 2 d.f., $p<0.001$) and, consequently, postop So_2 was significantly higher on the lateral side than on the medial ($f=16.83$, 1 d.f., $p<0.01$).

In contrast, So_2 on the control side fell significantly from baseline over the 7 day period ($f=32.84$, 2 d.f., $p<0.001$, Fig. 2b). There was no difference between the medial and lateral sides ($f=0.10$, 2 d.f., $p=0.91$).

Discussion

Up to 6% of all patients undergoing lower limb vascular bypass will suffer a complication of their groin wound. There has been little research in this field to establish vascular factors which may contribute to groin wound infection. Adequate blood flow and tissue oxygen supply are by far the most important determinants of successful wound healing.[9] Previous surgery, contamination of the operative site, handling of the tissue and the nutritional state of the patient are also important aspects which determine healing of wounds in general.

The results of this study have shown that following longitudinal groin incision a microvascular perfusion gradient develops across the wound. Overall, tissue oxygenation increased from baseline levels, in line with the hyperaemic blood flow caused by the acute inflammatory reaction. However, this response to injury was consistently smaller on the medial side of the wound than on the lateral and consequently the So_2 on the lateral side was significantly higher than on the medial. This difference was still apparent at 7 days, although to a lesser extent.

There was no indication on the medial side that values were particularly low immediately adjacent to the incision or that they became "normal" (i.e. comparable to the lateral side) away from it. Our results, therefore, reflect changes on the medial side of the groin rather than abnormalities just on the very edge of the wound.

None of the wounds studied became infected and all went on to heal primarily. It is therefore not possible to relate the changes in groin skin oxygenation with wounds that do become infected or break down. The pattern of results we did see, however, does support our hypothesis that a perfusion gradient develops across the groin following surgery. An alternative explanation may be that the lower medial So_2 is due to an increased oxygen extraction on this side of the wound. This interpretation would seem to have no pathophysiological basis, whereas a perfusion defect seems more plausible considering the anatomy of the groin's vasculature. Furthermore, So_2 measured with lightguide spectrophotometry in the skin appears to be strongly related to blood flow. The optical properties of the skin have a significant influence on the spectrophotometric signal and tend to reduce the calculated value.[10] A higher blood flow will attenuate this effect by virtue of the larger volume of haemoglobin present, and the measured So_2 is therefore increased. This also supports our interpretation of the results as being due to differences in perfusion rather than oxygen extraction.

What influence this might have on the incidence of infection is a matter for conjecture. Oxygenation on the medial side, despite being lower than on the lateral, still appears to be perfectly adequate to support tissue health, even in the presence of inflammation. (Values of So_2 lower than 5 or 10% have been shown to indicate hypoxia or poor healing viability in critical limb ischaemia.[6]) Possibly infection within a healing wound puts extra demands on the microcirculation, which cannot be met by the compromised perfusion. This reported difference between the medial and lateral skin So_2 is likely to be only a contributory factor rather than the main one.

Oxygenation in the control groin decreased following surgery, and this finding might possibly be explained by a "steal" phenomenon. Increased flow on the operated side may divert flow away from the contralateral limb. This may be as a result of the inflammatory hyperaemia or the increase in whole limb perfusion following revascularisation. However, at this point we are unsure of the reason for this result.

The above results and their possible explanation may well explain why transverse and oblique incisions have a better reputation for primary healing. In these incisions the cross-groin cutaneous blood supply would not be surgically interrupted and thereby carry one less risk factor for wound problems.

In summary, therefore, a significant tissue oxygenation gradient develops across the groin following longitudinal incision. This is possibly a consequence of the disruption in blood supply and may be a factor contributing to the relatively high incidence of infection in these wounds. Further study may be warranted to establish the pattern of oxygenation which occurs in those patients whose wounds do not heal without problem.

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