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Blood flow of the gluteus medius muscle

An animal study

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Abstract We investigated the effects of subperiosteal dissection on blood flow in the gluteal medius muscle in adult rabbits using the hydrogen washout technique. After the control blood-flow rate was determined, 8 rabbits were separated into 2 groups according to the direction of the dissection. The gluteal medius muscle was dissected from the iliac crest in the proximal-distal direction in 10 hips. In another 6 hips, the greater trochanter was osteotomised and the gluteus medius muscle was dissected from the ilium in the distal-proximal direction. Dissection of the middle third of the gluteus medius muscle caused the most significant reduction in blood flow, more than 50% in both groups. This result indicates that minimising damage to the mid-portion of the gluteus medius muscle is important for reducing the incidence of post-operative complications.

Résumé Nous avons examiné et étudié les effets de la dissection sous-périostale de l'écoulement sanguin dans les muscles médians fessiers de lapins adultes en utilisant la technique de lavage total à l'hydrogène. Après le contrôle de la proportion de l'écoulement sanguin, les lapins furent séparés en deux groupes selon l'objectif de la dissection. Dans le premier groupe, les muscles médians fessiers furent disséqués dans 10 hanches à partir de la crête iliaque dans la direction proximale-distale. Dans le second groupe de 6 autres hanches, le grand trochanter fut ostéotomisé, et le muscle moyen fessier fut disséqué à partir de l'ilium dans la direction distale-proximale. La dissection du tiers intermédiaire du muscle moyen fessier a provoqué la diminution la plus significative dans l'écoulement sanguin, soit plus de 50% pour les deux groupes. Ce résultat indique qu'une minimisation des lésions à la partie médiane du muscle moyen fessier est importante pour la réduction des complications post-opératoires.

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Introduction

Dissection of the gluteal muscles allows wide exposure of the hip, but it has a considerable rate of post-operative complications such as delayed wound healing or superficial infection. Long-lasting weakness of the abductor muscles which may cause a Trendelenburg gait is an additional possible disadvantage after this procedure. An adequate blood supply is mandatory for satisfactory post-operative healing of soft tissues and functional integrity of muscles. However, there have been few specific studies concerning the blood supply to gluteal muscles. The purpose of this study was to investigate the haemodynamics of the gluteus medius muscle in a living animal model.

Material and methods

Eight adult rabbits were lightly anaesthetised with intravenous sodium pentobarbital, and the gluteus medius muscle was exposed from the iliac crest to the greater trochanter. Arterial blood-pressure was continuously monitored from the artery of the ear and was controlled by varying the rates of fluid administration and the depth of anaesthesia. Blood flow was measured using the hydrogen washout technique [1]. A platinum electrode, insulated except for 1 mm at the tip and bent 90° in the middle, was inserted into a subcutaneous pocket in the flank. A mixture of oxygen (50%) and hydrogen (50%) was delivered to the animal through a nose cone. The rate of blood flow was calculated from the half-time of the decay of hydrogen from the gluteus medius muscle and was expressed as ml/min/100 g tissue.

After the control blood-flow rate had been determined, 16 hips were divided into 2 groups. The surgical procedures were performed under magnification. In Group 1, consisting of 10 hips, the origin of the gluteus medius muscle was stripped from the iliac crest and dissected in a proximal-distal direction in a fashion similar to that of the Smith-Petersen approach [7]. The gluteus medius muscle was mobilised from the ilium in 3 stages (one-third at each stage), and blood flow measurements were repeated after each stage of the dissection. In Group 2, consisting of 6 hips, the greater trochanter was osteotomised, and the blood flow of the gluteus medius muscle was measured. The gluteus medius muscle was then dissected from the ilium in the distal-proximal direction, which is the technique used in a tri-radiate acetabular extensile approach [3]. The same dissection stages were used and the same blood flow measurements were recorded as in Group 1.

To examine the vascular supply after distal one-third dissection or after distal two-thirds dissection from the ilium in Group 2, the abdominal aorta was exposed and barium sulphate solution was injected as a contrast media. The rabbits were then killed with intravenous sodium pentobarbital, the gluteus medius muscle was resected and an X-ray photograph was taken.

Results

The control blood-flow rate of the gluteus medius muscle averaged 26.6 ml/min/100 g in both groups. In Group 1, dissection of the proximal one-third of the gluteus medius muscle caused a significant decrease in blood-flow rate to 15.2 ml/min/100 g, which is 40% less than the control value ($P<0.01$). The blood-flow rate was significantly decreased to 5.0 ml/min/100 g after dissection of the proximal two-thirds (Fig. 1). In Group 2, blood-flow rate was not significantly decreased after osteotomy of the greater trochanter but dissection of the distal one-third of the gluteus medius muscle caused only an insignificant decrease in blood-flow rate. However, the blood-flow rate was significantly decreased to 0.5 ml/min/100 g after dissection of the distal two-thirds ($P<0.01$, Fig. 2).

Angiography of the gluteus medius muscle showed much lower contrast after two-thirds dissection than after one-third dissection (Fig. 3).

Fig. 1 Blood flow change in the gluteus medius muscle when dissected from the ilium in the proximal-distal direction by one-third

Fig. 2 Blood flow change in the gluteus medius muscle when dissected from the ilium in the distal-proximal direction by one-third after greater trochanteric osteotomy

Fig. 3 Angiography of the gluteus medius muscle after osteotomy of the greater trochanter. *Left*, angiography after distal two-thirds dissection in Group 2; *Right*, angiography after distal one-third dissection in Group 2

Discussion

We used hydrogen clearance to measure the blood flow of the gluteus medius muscle of rabbits, and we found it to be a simple, inexpensive, and accurate method for measuring blood flow, although there are some qualifications concerning its use [1, 9]. Clinically, the gluteus medius muscle was dissected in either the proximal-distal [5, 7] or the distal-proximal direction [3]. The consequences of these different dissection methods on the blood-flow rate of the gluteus medius muscle have not previously been investigated quantitatively.

Normally, resting muscle blood flow is reported to be in a range between 3–8 ml/min/100 g. This blood flow is increased up to 10 times when the muscle is contracted, although the blood flow was also influenced by intramuscular pressure [2, 6, 8]. Although the resting blood flow in this report was higher than that in other reports, our results demonstrate that blood flow in the gluteus medius muscle decreases significantly when it has been dissected (mobilised) two-thirds from its proximal or distal origins. One possible explanation for this decrease is that the mid-third portion of the gluteus medius muscle receives much of its blood flow from the ilium. A second possible explanation may be that the result could reflect the blood flow of a very localised region, so that the blood-flow rate decreases more when the mid-third portion is dissected (mobilised). It is suggested from our results that when the proximal two-thirds of the gluteus medius muscle is dissected, the remaining blood flow is sufficient for a resting muscle but is insufficient for a contracted muscle. After greater trochanter osteotomy and distal two-thirds dissection of this muscle, the blood

flow is inadequate even for a resting muscle. When the greater trochanter is osteomised blood flow in the gluteus medius is important for the blood supply to the greater trochanter [4], so in the tri-radiate extensile approach dissection of the mid-portion of the gluteus medius muscle should be minimised. Further studies are needed concerning blood flow in a contracted muscle and the long-term effects after the muscle has been re-attached to the iliac crest.

In conclusion, when performing a distal-proximal or proximal-distal dissection (mobilisation) of the gluteus medius muscle it is important to minimise damage to the mid-portion of the muscle in order to reduce the incidence of post-operative complications.

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