Short Report

The intramuscular arterial anatomy of the long head of biceps femoris muscle

DONAL SHANAHAN¹, R. K. JORDAN¹, A. COULTHARD², P. N. COOPER³ AND J. VARMA⁴

¹Anatomy and Clinical Skills Centre, Medical School, University of Newcastle, ³MRI Unit and ³Department of Histopathology, Royal Victoria Infirmary, and ⁴Department of Surgery, School of Surgical Sciences, Medical School, University of Newcastle, Newcastle upon Tyne, UK

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ABSTRACT

We have previously shown that the neurovascular anatomy and length of the long head of biceps femoris (LHBF) is suitable for its possible use in the creation of a dynamic perianal myoplasty to restore faecal continence. If intramuscular arterioarterial anastomoses exist between a muscle’s vascular pedicles then the delay procedure, i.e. ligating the vascular pedicles to the transposed section of the muscle, 4–6 wk before transposition, can be used to improve blood flow to the distal part of the transposed muscle. The intramuscular arterial anatomy of 20 biceps femoris muscles was shown by dissection (14) or radiographically (6). The mean entry point of the upper major vascular pedicle to the LHBF was 12 cm (s.d. 3.3) and the mean length of the LHBF was 36.8 cm (s.d. 1.8). Therefore the ratio between upper major vascular pedicle entry point and muscle length in 95% of specimens was 0.33 (0.2). In the present study intramuscular arterioarterial anastomoses were found between the arterial pedicles to the non-transposed and transposed sections of the LHBF and between the long and short heads of this muscle. Using the delay procedure would therefore theoretically allow the intramuscular arterioarterial anastomoses between the arterial pedicle to the nontransposed and transposed sections of the LHBF to open up enhancing blood flow to the distal part of the myoplasty.

Key words: Perianal myoplasty; arterioarterial anastomosis; human.

INTRODUCTION

Previous investigators have created a dynamic perianal graciloplasty by transposing the gracilis to the perianal region and stimulating the nerve to the transposed muscle electrically to restore faecal continence dynamically (Williams et al. 1990, 1991). A problem associated with this procedure was ischaemia of the distal part of the graciloplasty (Williams et al. 1990). This was overcome by delaying the graciloplasty procedure, i.e. ligating and dividing the minor vascular pedicles to the transposed section of the gracilis 4–6 wk before transposition. The transposed section is that part of the muscle manoeuvred completely out of its anatomical position. This modified graciloplasty procedure allowed intramuscular arterioarterial anastomoses between the dominant and minor vascular pedicles to open up, enhancing blood flow to the distal part of the graciloplasty (Patel et al. 1991a; Abercrombie & Williams, 1995). In a small group of patients the gracilis may be unavailable or unsuitable for transposition; the surgeon would therefore require a suitable alternative muscle. The criteria that a thigh muscle must fulfil if it is to be used to create a dynamic perianal myoplasty have been defined as follows (Shanahan et al. 1993). (1) The entry point of the dominant vascular pedicle to the muscle must permit its surgical manipulation around the anal canal. (2) The nerve supply to the muscle should be such that mass contraction of the transposed muscle occurs when the nerve is stimulated electrically. (3) The

Correspondence to Dr Donal Shanahan, Anatomy and Clinical Skills Centre, The Medical School, Framlington Place, University of Newcastle, Newcastle upon Tyne, NE2 2HH.
muscle should be of sufficient length to wrap around the anal canal. (4) The muscle should be expendable.

Previous studies based on the dissection of 24 (Shanahan et al. 1993) and 80 thighs (Shanahan, 1996) have shown that the percentages of long head of biceps femoris (LHBF) that fulfilled these criteria were 75% (18/24) and 71.25% (57/80). In these studies the vascular pedicles to the transposed section of the LHBF were divided, the LHBF was freed from the short head and its lower attachment to the fibula was sectioned. The freed muscle was wrapped around the anal canal and its lower attachment position onto the contralateral ischial tuberosity. Intramuscular arterioarterial anastomoses between the arterial pedicles to the nontransposed and transposed sections of the LHBF have not been established.

A biceps femoris myocutaneous flap has been used to provide cover following excision of ischial or sacral pressure sores (James & Moir, 1980; Topple et al. 1982; Kauer & Sonsino, 1986; Quaba et al. 1988). Zoetmulder & Baris (1995) undertook bilateral transposition of the biceps femoris myocutaneous flaps to the anal orifice to provide perineal cover in 3 patients. Therefore the vascular pattern to the biceps femoris myocutaneous flap permitted its transposition to the anal orifice. The biceps femoris can be transposed without major functional loss to the lower limb (Markhede & Stener, 1981).

The vascular patterns of skeletal muscles have been classified according to the number and entry points of their major vascular pedicles (Mathes & Nahai, 1982). The LHBF had originally been classified as having a type 2 vascular pattern, i.e. a single dominant and several minor vascular pedicles. However, studies by Cormack & Lamberty (1986, 1994) demonstrated that this classification is misleading in that there may be up to 4 separate major (≥ 2 mm in diameter) and several minor vascular (< 2 mm diameter) pedicles to the long head of this muscle. The vascular pattern to the LHBF seems to conform to a type 4, i.e. multiple pedicles of a similar size entering at multiple points along its belly; vascular anastomoses within the muscle were described as poor or only moderately developed (Cormack & Lamberty, 1994).

MATERIALS AND METHODS

Materials

Cadavers were allocated randomly either to the dissection or the radiological parts of this study ensuring that, as far as possible, there was an even distribution of female and male cadavers. The cadaveric component of this work is based on the dissection of 14 biceps femoris muscles to exhibit their intramuscular vascular anatomy. These muscles were harvested from the thighs of 7 embalmed cadavers (3 female, 4 male; age range 70–90 y, mean 82.6 y). The radiological component of this work is based on the injection of a radio-opaque agent into the upper major vascular pedicle of 6 biceps femoris muscles from 6 cadavers (3 female, 3 male; age range 50–94 y, mean 77.7 y).

Methods

With the cadaver in the prone position, skin covering the flexor compartment of the thigh was incised and reflected. A periosteal scraper was used to peel adipose tissue from the deep fascia of the thigh. Deep to this fascia the long head of biceps femoris (LHBF) lies contiguous to the semitendinosus muscle. A vertical incision was made in this fascia extending from the inferior border of the gluteus maximus to between the 2 heads of gastrocnemius. At approximately the midpoint of the flexor compartment of the thigh, this fascia was cut transversely to form a cruciate fascial flap. The gluteus maximus was sectioned at its sacral attachment to allow lateral reflection of this muscle based on the iliotibial tract. The profunda perforators were found as they emerged through the adductor magnus into the flexor compartment of the thigh. These vessels were cleaned and their branches to both heads of the biceps femoris were noted. Minor vascular pedicles to the biceps femoris were traced to their origin or confluence point. The major (≥ 2 mm in diameter) and minor arterial pedicles (< 2 mm in diameter) to the biceps femoris were ligated and divided. The diameter of major and minor arterial pedicles was measured using a micrometer calliper (Mitutoyo) at the point where the artery entered the muscle. The entry points of the vascular pedicles to the LHBF, the length of the LHBF and the point at which the LHBF became tendinous were measured from the upper border of the ipsilateral ischial tuberosity. The long head was freed by sharp dissection from its common attachment with the semitendinosus to the ischial tuberosity, the femoral attachment of the short head was cut, and the lower attachment of the biceps femoris to the fibula was sectioned.

Dissection of the intramuscular vascular anatomy of the biceps femoris

The biceps femoris was placed on a flat surface and any fascia covering its major vascular pedicles was removed. The intramuscular course of the largest
vascular pedicles, to the long and short heads of biceps femoris, was followed using large blunt ended scissors to part and divide the muscle fasciculi. With the aid of a magnifying lens, intramuscular ascending and descending branches were followed by blunt dissection to determine their distribution and anastomosis with other vascular pedicles.

**Radiological study of the intramuscular arterial anatomy of the biceps femoris**

A 1000 i.u./ml solution of streptokinase was prepared by reconstituting 250000 i.u. Kabikinase (streptokinase injection BP; Kabi Pharmacia Ltd, Milton Keynes, UK) in 5 ml water and adding to 250 ml of 0.9% saline (Steriflex). Over a 4 h period multiple 20 ml boluses of this solution were injected into the upper major arterial pedicle of the long head of biceps femoris. After at least 4 h this seemed to dissolve any agonal thrombosis within the muscle in that water injected into the upper major arterial pedicle caused fluid to extrude from the remaining arterial pedicles.

The muscle was placed in a radiolucent dish and the upper major pedicle was cannulated with a 19 G plastic cannula, 1 ml aliquots of Iorohexol 350 (Omnipaque 350, Nycomed UK) were slowly injected and sequential radiographs obtained (1 min time intervals). This process was repeated until fluid was seen extruding from the remaining arterial pedicles.

**Statistical analysis of data**

The mean length of the long head of biceps femoris and the mean entry point of its upper and where present lower major vascular pedicles into the muscle were determined. If only 1 major vascular pedicle (MaVP) was present this pedicle was treated as an upper MaVP. When more than 2 major vascular pedicles were found the entry points of the upper and lower pedicles were measured, the lower vascular pedicles were then treated as a single pedicle and a mean entry point was determined. The ratio between upper MaVP entry point and muscle length was determined. All statistical analyses were carried out using Minitab for Windows (1993) statistical package.

**RESULTS**

In the long head of biceps femoris (LHBF) in addition to direct intramuscular arterioarterial anastomosis between its major arterial pedicles (Fig. 1), communications were also found between its major arterial pedicles when these major pedicles anastomosed with a common minor arterial pedicle (Fig. 2). Vascular communications between the arteries supplying the long and short heads of this muscle were found (Figs 1, 2).

Fig. 1. Radiograph of a right biceps femoris muscle, Radio-opaque contrast agent was injected into the upper major arterial pedicle (Mu) of the long head of biceps femoris (L). Intramuscular arterioarterial communications (I) are seen between the major arterial pedicles (Mu, M) to the long head of this muscle and between the long and short heads of this muscle. (S) Short head of biceps femoris.
Standard deviation (s.d.) for a particular category is given in brackets following each mean. Mean entry point of the upper major vascular pedicle to the LHBF was 12 cm (3.3), range 7–20 cm. The mean entry point of the remaining major vascular pedicles to the LHBF was 16.3 cm (3.9), range 9–23 cm. The mean muscle length was 36.8 cm (1.8), range 34–39 cm. Therefore the ratio between upper major vascular pedicle entry point and muscle length in 95% of donors was 0.33 (0.2), i.e. ratio between means (0.33) and subtracting the ratio between means plus 2 s.d. from the ratio between means minus 2 s.d. (0.2). Mean point at which the LHBF became tendinous was 15.8 cm (1.7), range 13–19 cm.

In each specimen in this study the upper major arterial pedicles entered the LHBF at an acute angle and immediately divided into 2 main branches, i.e. transverse and inferior (Fig. 1). The transverse intramuscular branch coursed horizontally through the muscle dividing into ascending and descending terminal branches. The inferior intramuscular branch coursed down through the muscle dividing into anterior and posterior branches (Fig. 2). Anterior and posterior intramuscular branches anastomosed with intramuscular branches from the remaining arterial pedicles (Figs 1, 2). The remaining major (85% of specimens) and minor arterial pedicles entered the LHBF, coursed horizontally for approximately 1–2 cm, and then bifurcated into ascending and descending branches which anastomosed with intramuscular branches from other arterial pedicles (Figs 1, 2).

**DISCUSSION**

To elicit mass contraction of the dynamic perianal graciloplasty a stimulating electrode was sutured to the main trunk of the nerve to the gracilis rather than its branches (Patel et al. 1991). A suitable main trunk has been found proximal to the nerve branches innervating the majority of long head of biceps femoris muscles (Shanahan et al. 1993; Shanahan, 1996). The mean entry point of the nerve to the long head of biceps femoris (LHBF) was 14.3 cm (4.7), range 4–26 cm (Shanahan, 1996).

Superior transposition of a muscle may impair its blood supply, i.e. by kinking its major vascular pedicle, and lead to ischaemia and muscle necrosis. To try to prevent or limit kinking of the major vascular pedicles the transposed section of the superiorly based LHBF must be inferior to the entry point of its upper major vascular pedicle (MaVP). The approximate length of the LHBF can be calculated by measuring...
the distance between the patient’s ischial tuberosity and head/neck of fibula, this length multiplied by 0.53, i.e. 0.33 + 0.2 determines the lowest limit for the entry point of the upper MaVP to the muscle (in 95% of samples) and hence the possible length of the transposable section of the LHBF.

Although necrosis of the distal part of the transposed LHBF has not been reported, wrapping it around, or splitting it to enclose, the anal canal may impair blood flow throughout its distal part. The LHBF has been classified as having a type 2 or nearly a type 4 vascular pattern (Cormack & Lamberty, 1994); this study has shown that there was more than 1 major vascular pedicle to the majority of LHBF muscles (85%) thus showing that this muscle’s vascular pattern does not conform to the Mathes & Nahai (1982) classification, i.e. a single dominant pedicle (type 2) or multiple major pedicles (type 4). In this study the vascular pattern to the LHBF differs from a type 4 vascular pattern in that there are well developed intramuscular anastomoses between its arterial pedicles. Clinical experience with the dynamic perianal graciloplasty has shown that preliminary ligation of the minor vascular pedicles to the transposed section of the LHBF would be advantageous (Shanahan et al. 1993). Therefore, following delay, intramuscular communications between its vascular pedicles may prevent ischaemia and necrosis of the distal part of the transposed LHBF. Cormack & Lamberty (1994) found that there were no vascular communications between the vessels supplying the long and short heads of this muscle. These were observed in the present study.

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**REFERENCES**


