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Prevention of perioperative limb neuropathies in abdominal free flap breast reconstruction[☆]

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Summary *Background and aims:* Perioperative peripheral neuropathies are a significant cause of post-operative morbidity in patients undergoing prolonged procedures. The aims of this study were to determine the incidence and possible causes of peripheral neuropathy in patients undergoing abdominal free flap breast reconstruction and to develop methods of ameliorating this problem.

Methods: A 4-year retrospective study of patients undergoing abdominal free flap breast reconstruction by a single surgeon and anaesthetist was undertaken to determine the incidence and potential causes of perioperative neuropathy. A new positioning protocol was introduced to minimise the stretch on the brachial plexus and to protect peripheral nerves from compression forces. In addition, regular intraoperative physiotherapy was introduced.

A prospective study was then conducted on patients managed by the same team to evaluate the effect of this change in practice on the subsequent incidence of peripheral neuropathies. *Results:* Over the 4-year retrospective period, 93 consecutive patients underwent abdominal free flap breast reconstruction, six of whom (6.5%) developed a peripheral neuropathy. Following the introduction of the new positioning protocol, prospective data collected on 65 consecutive patients showed no further occurrences of perioperative neuropathy ($p = 0.04$). There were no significant differences in the characteristics between the two cohorts.

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Conclusion: Perioperative peripheral neuropathy in abdominal free flap breast reconstruction is a preventable problem. This paper presents a peripheral neuropathy prevention protocol for managing these patients.

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Introduction

Perioperative neuropathies are peripheral neuropathies that occur far from the site of surgery and manifest during the post-operative period. In 1894, Budinger was the first to recognise the link between intraoperative positioning causing stretching or compression of nerves and post-operative neuropathies.¹ Both stretching and compression can cause occlusion of the vasa nervosum, produce focal nerve ischaemia and result in permanent neurological deficits.²

General anaesthesia renders nerves susceptible to stretching and compression because reduced muscle tone allows limbs to be placed in positions that would not be tolerated normally.

Although mechanical forces are recognised as the most common cause of perioperative neuropathy, other factors must also be considered. Despite our understanding of the theoretical pathophysiology of perioperative nerve injury, most authors have not described a cause-and-effect relationship.³ In the majority of cases involving peripheral nerve injury investigated by the American Society of Anaesthesiologists in a closed claims analysis, the mechanism of injury was not apparent.⁴

The true incidence of perioperative neuropathy in prolonged procedures is also not known, with considerable variation in its reported incidence.⁵ It is a complication that attracts significant litigation. After death, perioperative neuropathy is the second most common cause of litigation accounting for 16% of claims.⁶

We diagnosed a significant brachial plexus injury in a patient who underwent a free deep inferior epigastric artery perforator (DIEP) flap breast reconstruction by the senior author (JMO'D), and we found similar cases in the literature as well. Thus, we aimed to determine the incidence, possible causes and methods of ameliorating the problem of perioperative neuropathy in patients undergoing abdominal free flap breast reconstruction.

Patients and methods

This study was performed in two parts. The first was a 4-year retrospective review of consecutive patients who underwent an abdominal free flap breast reconstruction performed by the senior author (JMO'D) with the same consultant anaesthetist (DH) between February 2003 and February 2007. The second was a prospective study of consecutive patients who underwent the same operation employing the same anaesthetic agents performed by the same team between March 2007 and December 2010, but

after the introduction of a new intraoperative positioning protocol. Data collected on both cohorts included patient age, body mass index (BMI), smoking status, type of anaesthesia employed, intraoperative positioning including length of time in the sitting position for abdominal closure and flap shaping, overall length of surgery, type of flap used, microvascular ischaemic time, return to theatre for flap salvage, flap loss, blood loss, fluid requirements including the type used and fluid balance, mean arterial pressure (MAP) changes throughout each operation along with comparisons to the preoperative MAP, temperature changes throughout surgery, previous medical history and medication history including chemotherapy, as well as the occurrence, type and laterality of any neuropathy identified. All flap anastomoses were performed to the internal mammary vessels.

Statistical analysis was conducted using two-tailed Student's test and two-tailed Fisher's exact test with significance taken at the 5% level.

Patient positioning

Prior to February 2007, all patients were positioned with their heads in neutral position, the shoulders abducted to approximately 60°, the elbows in extension and the forearms in supination on padded arm boards (Figure 1a). Gel pads were used in all cases to minimise pressure-related problems. Towards the end of the procedure, the patients were placed in a semi-sitting position at approximately 40° for abdominal closure and flap shaping. Throughout the procedure, the arms were held in the same position on abducted arm boards by well-padded straps. Anastomoses to the internal mammary vessels were performed with the surgeon either sitting or standing between the abducted shoulder and the side of the patient. The range of shoulder abduction was usually increased beyond 60° but not 90° during this phase of the surgery such that the surgeon could complete the anastomoses comfortably (Figure 1b).

By 2007, the senior author (JMO'D) was aware that a few patients had presented with perioperative neuropathy following abdominal free flap breast reconstruction. Following a literature review and assuming mechanical forces to be the most likely cause, the patient's positioning was changed and intraoperative on-table physiotherapy was also introduced. From March 2007 to December 2010, patients were positioned with their heads in a neutral position, the shoulders internally rotated and the upper arms adducted and placed close to the side of the table. The elbows were slightly flexed and the forearms were placed in a pronated position (Figure 2a). This position was chosen to minimise stretch on the brachial plexus and to protect

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