Evaluation of Flap Tissue Viability by F-18 FDG PET/CT

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Abstract A 60-year-old man underwent vertical rectus abdominis myocutaneous flap to reconstruct a left lateral chest wall defect. For assessment of viability of muscle flap, F-18 fluoro-2-deoxyglucose (FDG) positron emission tomography/computed tomography (PET/CT) was performed 15 days after surgery. The FDG PET/CT showed a small metabolic defect in the left lateral chest wall. During follow-up, necrotic change of the graft was observed, and the site was in accordance with the area where the metabolic defect was observed in the FDG PET/CT. As a result, debridement and wound closure was performed. This case suggested that the FDG PET/CT should be a useful method for the monitoring of muscle viability after flap surgery.

Keywords Fluorine-18-fluorodeoxyglucose · Positron emission tomography · Myocutaneous flap · Tissue viability

Introduction

Free flap transplantation is one of the treatments of choice for extensive wound defect [1]. The important factor for successful flap is early detection of flap failure [2]. Visual inspection is a widely used monitoring method, but it is not objective. To date, many kinds of monitoring techniques for the detection of post-operative flap ischemia have been developed [3]. Such

methods include photoplethysmography, electrical impedance plethysmography, intravenous fluorescein test, assessment of muscle contraction, surface temperature monitoring, transcutaneous oxygen/carbon dioxide tension monitoring, Doppler ultrasonography, etc. [4–6]. However, there is no method used as a standard [7]. Due to no reliable objective and simple detection techniques, various methods are used to monitor the flap viability [8].

Monitoring methods have also been developed using various radionuclide imaging approaches. Technetium-99 m (Tc-99 m) and thallium-201 (Tl-201) were used to evaluate free muscle flap viability [4, 6, 9]. Tl-201 and Tc-99 m have been used in the evaluation of skin and muscle perfusion [4, 6]. Using F-18 fluoro-2-deoxyglucose (FDG) positron emission tomography (PET) scanning to assess skeletal muscle viability has been reported [6]. PET is able to scan the regional blood flow of viable tissue directly [8].

We report a case of detecting non-viability of free-flap muscle in the chest wall showing metabolic defect on FDG positron emission tomography/computed tomography (PET/CT) scan.

Case Report

A 60-year-old man underwent left lower lobectomy due to large volume hemoptysis and bronchiectasis 24 years ago. Left pneumonectomy was performed because tuberculosis had destroyed the lung and severe bronchiectasis 9 years ago. After pneumonectomy, complications such as empyema with bronchopleural fistula developed. To resolve the complication, Eloesser procedure wound debridement was done, and reconstruction of the chest wall defect was attempted. However, lack of donor site tissue precluded the reconstruction at that time.

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Fig. 1 A 60-year-old man underwent VRAM flap to reconstruct the left lateral chest wall defect. **a** Large lateral chest wall defect before reconstruction. **b** Immediate post-op image of chest wall. **c** Necrotic tissue in the lateral chest wall (*arrow*). **d** Post debridement and wound closure image

He underwent vertical rectus abdominis myocutaneous (VRAM) flap to reconstruct the left lateral chest wall defect 7 years after the previous failed attempt at reconstruction. There was a large defect in the left lateral chest wall prior to the reconstruction (Fig. 1a). There was no immediate postoperative complication after the reconstruction surgery (Fig. 1b).

Fifteen days after left lateral wall reconstruction, FDG PET/CT was performed to evaluate the viability of the muscle flap. The exam was conducted using regional PET/CT over the chest area. At that time, there was no definite clinical situation indicating flap failure. However, the operation site was large and it needed high surgical technique. Therefore the surgeons wanted to assess flap viability due to the slow recovery of the patient. FDG PET/CT images exhibited diffuse FDG uptake around the transplanted tissue, and metabolic defect in the left lateral chest wall (Fig. 2). During follow-up, fat necrosis of the graft was detected, which corresponded with the metabolic defect area in the PET/CT (Fig. 1c). Debridement and wound closure was performed 4 weeks after the PET/CT scan (Fig. 1d).

Discussion

Musculocutaneous flaps have been the preferred choice for covering chest wall defects [10]. To cover the epigastric,

sternal and the anterolateral chest wall, VRAM or transverse rectus abdominis myocutaneous are used [10, 11]. A VRAM flap has advantages including sufficient skin and soft tissue supply, low complication and high success rates [11, 12]. To enhance free flap success, early identification and salvage of failing flaps are required [5].

Recently, various radionuclide techniques have been reported to monitor tissue viability [4, 6]. Tl-201 has been used for the evaluation of ischemic change of the soft tissue [13–15]. Tc-99 m pyrophosphate has been used for detecting skeletal muscle necrosis [16]. Tc-99 m sestamibi imaging has been described as a technique for monitoring free muscle flap viability [4]. These imaging techniques have advantages in that they are widely available at a relatively low cost. Tissue blood flow and perfusion are evaluated with these techniques. However, these radionuclides are used for planar or SPECT images. They have limited sensitivity and spatial resolution compared with PET [17].

FDG PET represents metabolic activity of tissue [18]. FDG PET scanning was used to monitor skeletal muscle viability after free-flap muscle transfer [6]. Higher FDG accumulation was reported in viable muscle flaps than in non-viable flaps [6, 18]. It is suggested that FDG PET plays an important role in the evaluation of skeletal muscle viability after muscle flap [6, 18]. Aigner et al. [19] showed that patients with favorable outcome after flap

Fig. 2 FDG PET/CT was performed to evaluate the viability of the muscle flap. PET/CT scan showed a small photon defect in the left lateral chest wall (*arrow*). **a** PET image. **b** PET/CT fusion image

surgery revealed no photopenic defects in FDG PET, whereas tissue with large photopenic defect in FDG PET showed early necrosis [18]. There is a limit using PET due to its relatively high cost [4]. However, it is more cost-effective to detect non-viable tissue in an early phase when the patients have a high risk of necrosis or large extent of flap.

In this case, a small photon defect of the lateral chest wall was shown in the FDG PET/CT. This finding suggested non-viable tissue. In the follow-up period, the tissue which corresponded with the photon defect area in the PET/CT showed necrotic change. FDG PET/CT is a valuable diagnostic technique used in the general field, besides oncology. We suggest that FDG PET/CT should be considered to evaluate flap viability following free flap transfer if highly sensitive and accurate methods are needed.

Conflict of Interest Inki Lee, Seo Young Kang, Chan-Yeong Heo, Ho-Young Lee and Sang Eun Kim declare that they have no conflict of interest.

Informed Consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000. The study design and exemption of informed consent were approved by the Institutional Review Board of Seoul National University Bundang Hospital.

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