Volume 4 | Issue 5 | 2024

ISSN | 2771-019X

Journal of
Clinical & Medical Images
Case Reports

Open Access | Case Report

# Treatment of osteonecrosis of the femoral head by using the fibular graft with double vascular pedicles: A case report

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## Abstract

**Introduction:** The operation is aimed to avoid a nonunion of the grafted bone flap and subtro chanter fracture that may occur in traditional vascularized fibular grafting, which are considered to be the most effective in the treatment of the Osteonecrosis of the Femoral Head (ONFH) for younger patients as well as to preserve mechanical supporting element of the fibula by making a vascularized fibular graft.

**Presentation of case:** We applied a new vascularized fibular grafting to a 32-aged patient with ONFH.

**Discussion:** We believe that, though this technique has shortcomings in which 2 operations have to be performed, it can reduce epiphenomenon and safely reach the goal for operation, and we are going to introduce it in the magazine.

**Conclusion:** In a 5-years follow-up, the fibular graft survived safely, maintaining support and the femoral head was preserved without epiphenomenon.

**Received: Sep 30, 2024**

**Accepted: Oct 21, 2024**

**Published Online: Oct 28, 2024**



**Cite this article:** Pak H, Riong Ri H, Gyong Jong R, Jin Kim H, Gwon Won S, et al. Treatment of osteonecrosis of the femoral head by using the fibular graft with double vascular pedicles: A case report. J Clin Med Images Case Rep. 2024; 4(5): 1750.

**Keywords:** Osteonecrosis of the femoral head; Vascularized fibular grafting; Double vascular pedicle; Case report.

**Abbreviations:** ONFH: Osteonecrosis of the Femoral Head; NVF: Neo Vascularized Flap; THA: Total Hip Arthroplasty; FVFG: Free Vascularized Fibular Grafting; VFPG: Vascularized Fibular Periosteum Grafting.

## Introduction

The goal in treatment of ONFH is to relieve pains and preserve the femoral head as long as possible. The traditional vascularized fibular grafting has been demonstrated as a great value in treatment of femoral head osteonecrosis for younger patients [1,3-6]. The free vascularized fibular grafting has been shown to support the subchondral architecture and restore local circulation for the necrotic femoral head in treating ONFH [2]. Following this traditional operation, however, there may be a failure of microvascular anastomosis, a risk of proximal femoral fracture, subtrochanter fracture and nonunion of the grafted bone [2]. For this reason we applied a new vascularized fibular grafting to a 32-aged patient with aseptic necrosis. The operation is aimed to avoid a nonunion of the grafted bone flap and subtrochanter fracture as well as to preserve mechanical supporting element of the fibula by making a vascularized fibular graft. And it is aimed to graft a vascularized fibular flap with double vascular pedicles in order to enhance of the local circu-

lation as well as to reduce failure of vascular anastomosis. Free microvascular transplant of a vascular bundle was described by Hussl for treatment of insufficient vascular supply to a fully functional finger with atrophy and sensation of coldness following replantation or severe crush injury. Also it is possible to graft a double vascularized pedicled fibular flap that was made by grafting the blood vessel into the marrow cavity of the fibula, based on the principle of converting a random pattern flap into axial pattern one using the vascular bundle in the Neovascularized Flap (NVF), because bone graft is to revascularize. We introduce this method of treatment in a magazine since it may reduce the incidence of epiphenomenon likely to occur after operation.

## Case presentation

The patient was aged 32. He has suffered from the disease for 7 years, with no other complications. The operation was performed, divided into 2 stages. In the primary operation, it was to make a graft which satisfies the above-said condition. The secondary operation consisted of processing the muscle cuff around the fibula and grafting the double vascularized fibula flap into focus of the femoral head. Also we evaluated circulation of the pedicle and status of the vascular anastomosis under direct vision (Figure 1). The detailed procedure was as follows; Obtaining the fibula flap was the same as the traditional method. The vascular pedicle was made more than 7 cm long. Longitudinal incision was performed between the rectus femoris muscle and vastus lateralis muscle, beginning from the level just below the greater trochanter; traction was applied to the rectus femoris muscle inward and vastus lateralis muscle outward; and then the descending and transverse branches are ascertained in the lateral circumflex femoral artery running over the vastus intermedius muscle. At the point to up to 14 cm from the bifurcation of the transverse branch, descending branch was ligated and cut. After which involving the fascia of the vastus intermedius muscle in width of 2 cm around the descending branch, descending branch was separated proximally about 7 cm, with the muscle branches ligated and cauterized. The obtained marrow cavity of the fibular flap was given a tunnel 6 mm in diameter, and then the separated bundle of the descending branch of the lateral circumflex femoral artery was passed through, and anastomosis was made between the nutrition vessel of the fibula and the transverse branch of the lateral circumflex artery. After that, the fibular flap was put on the vastus intermedius muscle to avoid twisting of the vascular pedicle, and layer-to-layer suturing is made. The secondary operation was conducted 6 weeks later. Incision was made again; the vascularized fibular graft was separated, leaving the vascular pedicle in place; the conditions of circulation of the graft and vascular anastomosis was ascertained (Figure 3a), and the muscle cuff around the fibula was resected (Figure 3b). The resection was performed until the periosteum appears, except for the area around the nutrition vessel of the fibula. In this case it was possible to observe the condition of the graft circulation from the status of bleeding in the graft, and the pulsation was confirmed in the vessel transplanted into the bone marrow (Figure 3a). Next, grafting was performed into focus of the femoral head using a double vascular pedicle consisting of the transverse branch and descending one in the lateral circumflex artery, and the bundle of the lateral circumflex vessel was separated proximally as much as possible to prevent twist and tension of the pedicle (Figure 5a). And then, penetration was made from the lateral femoral cortex into the femoral head below the greater trochanter; on endoscope focus in the femoral head was curated (Figure 2a,2b); the cancellous bone chief of the iliac crest was grafted and the fibular graft was inserted as pedicle. The condition of the inserted fibular graft was ascertained on X-rays, and the operation was finished with layer-to-layer suturing (Figure 5b). Here, the processed fibular graft was 12 mm diameter (Figure 4); the passage for grafting was 13 mm in diameter, which was markedly smaller than the traditional graft in thickness of 17-21 mm.

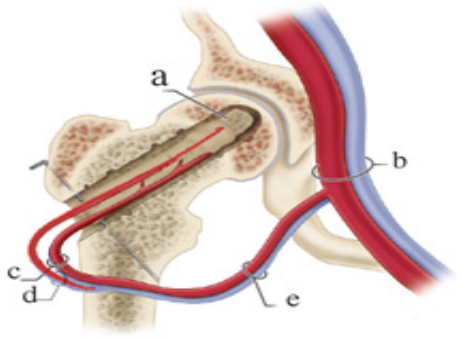



**Figure 1:** Illustration of the fibular grafting with double vascular pedicles. **(a)** Cancellous bone chips. **(b)** Femoral artery. **(c)** Anastomosis of the fibular vessel and transverse branch of the femoral lateral circumflex vessel. **(d)** Descending branch of the femoral lateral circumflex vessel inserted into the bone marrow cavity of the fibula. **(e)** Bundle of the femoral lateral circumflex vessels.

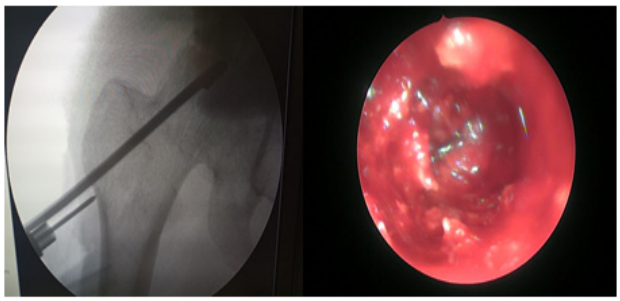



**Figure 2:** Decompression using guide and endoscopic finding in the primary operation. **(a)** Decompression using guide. **(b)** Endoscopic finding.

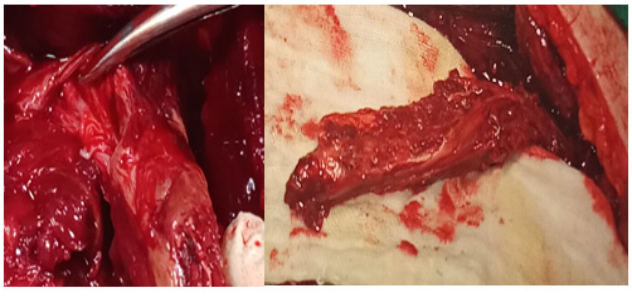
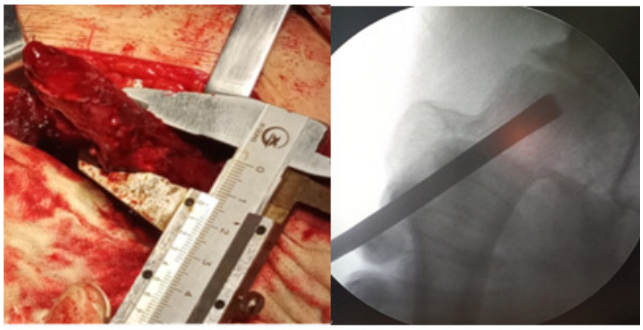
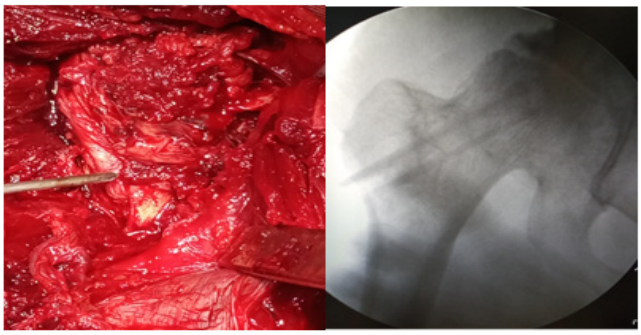



**Figure 3:** Confirmation of the pulse of the vessel grafted into the bone marrow and status of vascular anastomosis in the secondary operation and resection of the muscle cuff. **(a)** Confirmed the status of vascular anastomosis in the fibula. **(b)** Confirmed the pulse of the vessel grafted into the marrow cavity, resection of the muscle cuff from the fibula.



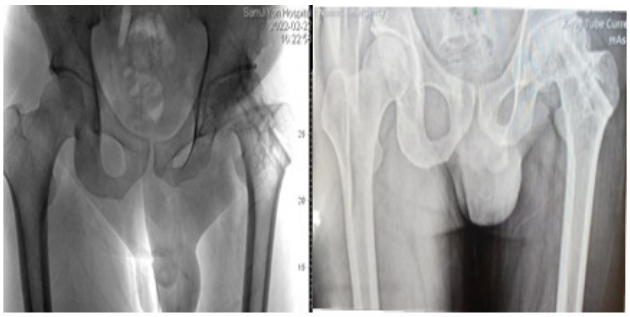
(a) (b)

**Figure 4:** Penetration of the femoral head adequate to the diameter of the fibula processed from the muscle cuff. **(a)** Measuring the thickness of the vascularized fibula flap. **(b)** Penetration of the femoral head adequate to the diameter of the fibula.



(a) (b)

**Figure 5:** Vascular pedicle and status of insertion. **(a)** Vascular pedicles (Kirschner wire indicates the vascular pedicle). **(b)** Status of insertion of the fibula bone flap.



(a) (b)

**Figure 6:** Postoperative finding. **(a)** Postoperative finding 3 years. **(b)** Postoperative finding 5 years.

## Discussion

Various surgical techniques have been attempted to avoid a Total Hip Arthroplasty (THA) and preserve the femoral head for younger patients, including core decompression, various types of osteotomies, and non vascularized bone grafting [4]. However, none of these techniques have been proved reliable. Commonly, patients have few treatment choices other than joint arthroplasty when the subchondral collapse of the femoral head occurs [5]. The vascularized bone flap transfer has demonstrated a great value in treatment of femoral head osteonecrosis [1,3-6]. The Free Vascularized Fibular Grafting (FVFG) has been shown to support the subchondral architecture as well as restore local circulation for the necrotic femoral head in treatment of ONFH [1-3,6]. FVFG has been also proved osteoinductive and osteoconductive potential, which is especially preferred in younger patients with early precollapsed stages of osteonecrosis [1-3]. The traditional surgical technique of surgical management of ONFH, which the vascular pedicle is dissected prior to osteotomy in the harvest of the vascularized fibular graft and removal of the necrotic tissue of the femoral head is performed through the lateral cortex approach, may have some disadvantages including prolonged surgery time, difficulties in removal of the necrotic tissue, inset of the vascularized bone graft and microvascular anastomosis, and risk of the proximal femoral fracture [2]. The muscle cuff around the fibula and vascular pedicle in the osseous tunnel might cause bony nonunion [2]. A 21 mm reamer is used in the original technique in the femur for a larger fibula. The larger the hole in the lateral cortex, the bigger the risk of a subtrochanteric fracture [1,2]. In microvascular reconstruction of the mandible, another researches have found that even several osteotomies can be made to the fibula without compromising fibular circulation [2]. With that experience in mind, they started to shape the fibula to make the circumference smaller for reaming of the femur [2]. By this method the size of fenestration in the femoral cortex can be reduced. However, the size of the hole has to be large enough to provide sufficient space for the vascular pedicle [2]. However other authors reported that, despite the theoretically enhanced osteogenic properties of vascularized periosteum tissue transfers over the classic FVFG technique, VFPG failed to adequately forestall femoral head from collapse in their patients [1]. Thus the negative outcomes they experienced at short -term follow-up with the use of VFPG highlighted the importance of FVFG as a mechanical support element in the treatment of ONFH [1]. For this reason, we planned to graft a new vascularized fibular graft capable of preventing the failure of vascular anastomosis and the development of nonunion of the grafted flap and subtrochanteric fracture while sufficiently restoring support and local vascular circulation for the necrotic femoral head. In this case it was possible to observe the condition of the graft circulation from the status of bleeding in the graft, and the pulsation was confirmed in the vessel transplanted into the bone marrow. We could directly ascertain a safe circulation of the graft and closely graft the total fibular graft into the femoral head via a smaller osseous tunnel than an original technique, using the double vascular pedicle. In a 5-years follow-up, the patient could safely preserve the femoral head without pain.

## Conclusion

We could directly confirm the circulating state of the vascularized fibular graft already processed in our patient and closely transplant the fibular flap into the femoral head through a tunnel in smaller diameter using the double vascular pedicle rather than the traditional method. In a 5-years follow-up, the fibular graft survived safely, maintaining support and the femoral head was preserved.

## Declarations

**Declaration of competing interest:** The authors report no declarations of interest.

**Ethical approval:** The health ethics committee had approved the study on the treatment of ONFH.

**Consent:** Written informed consent was obtained from the patient for publication of this case report and accompanying images.

**Author's contribution:** Hyon Pak: Treating consultant, main author, writing the manuscript. Huang Riong Ri, Riu Gyong Jong: Writing the manuscript, reviewing the literature, preparing the images. Hyon Jin Kim: Data collection, reviewing the literature.

Sung Gwon Won: Academic review. Chol Hyok Kim: Postoperative management and data collection.

**Registration of research studies:** It has been registered in our country.

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