SUBSPECIALTY PROCEDURES

VASCULARIZED ILIAC BONE FLAP TRANSFER FOR EARLY AND MIDDLE STAGES OF OSTEONECROSIS OF THE FEMORAL HEAD

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Abstract

Background: Osteonecrosis of the femoral head often affects young active adults and leads to destruction of the hip joint and severe arthritis¹⁻⁴. Despite improvements in hip arthroplasty design and techniques, it is unlikely that prosthetic replacements will endure for life. Alternatively, various head-preserving procedures have been used to avert or delay the need for a total hip arthroplasty⁵⁻¹¹. Vascularized iliac bone flap transfer is a joint-preserving procedure that can be considered for younger patients with early or middle-stage osteonecrosis of the femoral head.

Description: The major steps of the procedure include (1) an anterior approach to the affected hip, (2) creation of a bone flap from the iliac crest pedicled with the ascending branch of the lateral circumflex femoral artery, (3) obtaining cancellous bone from the iliac crest, (4) exposure of the anterior aspect of the femoral neck, (5) creation of a 2 × 2-cm window at the junction of the femoral head and neck, (6) debridement and removal of the necrotic bone, (7) implantation of the cancellous bone and vascularized bone flap, (8) fixation of the bone flap, and (9) layer-by-layer wound closure. Complications are rare, and full weight-bearing is allowed at 6 months postoperatively.

Alternatives: Alternatives to the procedure include core decompression, nonvascularized bone-grafting, free vascularized fibular grafting, and vascularized greater trochanter grafting.

Rationale: Various femoral head-preserving procedures have been reported. Core decompression is an effective femoral head-preserving procedure and is recommended as the first surgical treatment option for symptomatic small to medium-sized precollapse lesions. However, outcomes are poor when a patient has a large lesion or femoral head collapse. The advantage of vascularized iliac bone flap transfer is that it allows femoral head decompression, restores blood supply, and provides structural support. Thus, this procedure can be performed in patients with later osteonecrosis stages before hip osteoarthritis has progressed.

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Introductory Statement

Vascularized iliac bone flap transfer is a joint-preserving procedure for early or middle-stage osteonecrosis of the femoral head in younger patients that removes the necrotic bone of the femoral head, restores the blood supply, and provides new bone and mechanical support for the femoral head.

Indications & Contraindications

Indications

- Association Research Circulation Osseous (ARCO) stage-II or III osteonecrosis of the femoral head.
- Younger patients (<45 years).

Contraindications

- ARCO stage IV.
- A defect of the iliac crest due to previous surgery.
- Active infection of the hip joint or any other region.
- Isolated necrotic lesions in the posterior part of the femoral head.

Step-by-Step Description of Procedure

Step 1: Positioning and Incision

With the patient supine on a regular orthopaedic table and the affected hip elevated 30°, use an anterior approach.

- Identify and mark the anterior superior iliac spine and the greater trochanter.
- Make an approximately 12-cm curved incision 2 cm proximal to the anterior superior iliac spine.
- Protect the lateral femoral cutaneous nerve until the tensor fasciae latae muscle is exposed (Video 1).

Video 1 Positioning and incision.

Step 2: Identification of the Pedicle

Identify the ascending branch of the lateral circumflex femoral artery.

- Locate the interval between the sartorius muscle and the tensor fasciae latae and split it in the direction of the skin incision.
- The ascending branch of the lateral circumflex femoral vessels (ALCFVs) beneath the rectus femoris muscle enters the tensor fasciae latae laterally (8 to 10 cm distal to the iliac crest) and ascends directly to the anterosuperior aspect of the iliac crest along the tensor fasciae latae muscle (Fig. 1 and Video 2).
- Isolate and protect the pedicle (ALCFVs).

Fig. 1

Fig. 1 Identification of the ascending branch of the lateral circumflex femoral vessels (ALCFVs) between the rectus femoris muscle and the tensor fasciae latae (TFL).

Video 2 Identification of the pedicle.

Step 3: Bone Flap and Cancellous Bone Preparation

Take a vascularized bone flap pedicled with the ALCFVs and cancellous bone from the iliac crest.

- Incise the superficial one-third of the tensor fasciae latae muscle from the medial edge and keep it as a flap. The width of the tensor fasciae latae dissection depends on the bone block needed (on the basis of the necrotic lesion size, which is normally 2 to 2.5 cm), and the length of the tensor fasciae latae dissection depends on the length from the iliac crest to the ALCFVs entry point of the tensor fasciae latae muscle. Dissection of the tensor fasciae latae muscle from the iliac crest to the ALCFVs entry point facilitates transfer of the bone block, and this muscle flap should be sutured back to the iliac crest to minimize the potential for dysfunction of the tensor fasciae latae muscle.
- The ALCFVs run along the deeper muscle bundles to the iliac crest (posterior two-thirds of the tensor fasciae latae). As little of the muscle bundles should be taken as possible, without compromising the bone flap blood supply. A larger bone flap will be taken for a larger necrotic lesion, but management of the muscle is the same.
- Do not do further dissect the vessels in these muscle bundles to avoid vessel injury.
- Take a bone block from the iliac crest that is approximately 2.5 cm long and 1.5 cm wide, with a vascular pedicle as long as 10 cm (Figs. 2 and 3).
- Keep the inner plate of the ilium in situ in order to protect the origin of the sartorius muscle and maintain the intact shape of the ilium. Also, the anterior and lateral plates of the iliac flap alone could provide enough mechanical support for the necrotic lesions.
- Save the pedicled bone block in saline solution-wrapped gauze for later use.
- Take a 2 to 3-mL volume of autologous cancellous bone from the iliac crest, and use bone wax to seal the bone surface (Video 3).

Fig. 2

Fig. 3

Fig. 2 The iliac bone block is approximately 2.5 cm long and 1.5 cm wide.

Fig. 3 The vascularized bone block is taken from the iliac crest. TFL = tensor fasciae latae.

Video 3 Bone flap and cancellous bone preparation.

Step 4: Debridement

Debride the necrotic bone through a bone window made at the junction of the femoral head and neck.

- Expose the anterior aspect of the capsule in the interval between the rectus femoris muscle and the gluteus medius muscle.
- Incise the capsule in a T-shape to expose the femoral head and neck.
- Make an approximately 2-cm-long and 2-cm-wide bone window at the femoral head-neck junction using an osteotome (Fig. 4). The window should be open on the basilar part of the femoral head to reduce cartilage damage in weight-bearing areas; there should be at least 1-cm-wide intact bone remaining on both sides of the bone window to avoid femoral neck fracture.
- Remove the dead bone with a high-speed abrasive drill according to findings on preoperative magnetic resonance imaging (MRI) or computed tomography (CT), and curet a cavity in the femoral head until bleeding can be seen (Fig. 5). Intraoperative radiography can be used to make sure that the drill and curet do not cut out the subchondral bone.
- Take care not to “cut out” the subchondral bone and compromise femoral head cartilage (Video 4). If the subchondral bone is broken, only cartilage is left between the joint space and the necrotic lesion. In this situation, we make sure that enough cancellous bone is implanted, and impacted firmly; otherwise, there might be high risk of postoperative collapse of the femoral head.

Fig. 4

Fig. 5

Fig. 4 A 2-cm-long and 2-cm-wide bone window is made at the femoral head-neck junction using an osteotome.

Fig. 5 Debridement with a high-speed abrasive drill and creation of a cavity in the femoral head with a curet.

Video 4 Bone window made at the femoral head-neck junction and necrotic bone debridement.

Step 5: Bone Implantation

Implant the cancellous bone and vascularized bone flap.

- Transfer the autologous cancellous bone taken from the iliac crest into the excavated region of the femoral head and impact it firmly. Visible bleeding of the bone flap is an indicator that the flap is vascularized intraoperatively. In our hospital, we performed preoperative digital subtraction arteriography (DSA) routinely in all patients with vascularized bone-grafting. However, because DSA is an invasive assessment, we performed it postoperatively (at 6 weeks) only in some patients, with their agreement, to evaluate the blood supply of the bone flap and the femoral head.
- Try to elevate the collapsed segment of the femoral head with bone impaction instruments (Fig. 6).
- Transfer the vascularized bone flap pedicled with the ALCFVs to the femoral head. Place the graft's cancellous bone surface up against the subchondral bone of the necrotic segment and impact it to make the surface of the bone flap match the cortical surface of the bone window, to reduce the risk of postoperative impingement (Fig. 7).
- Make sure that the bone flap is fixed firmly (Video 5). If the bone flap is too small or not stable in the femoral head, use absorbable screws to fix the bone graft.

Fig. 6

Fig. 7

Fig. 6 Bone impaction instruments used to elevate the collapsed segment of the femoral head

Fig. 7 Transfer of the vascularized bone flap pedicled with the ALCFVs to the femoral head.

Video 5 Implantation of the cancellous bone and vascularized bone flap.

Step 6: Wound Closure

Close the wound layer by layer (Video 6).

- Suture the superficial one-third of the tensor fasciae latae muscle back during closure.
- Be careful not to ensnare the lateral femoral cutaneous nerve on the femoral site.
- A drain can be used for 24 to 48 hours.

Video 6 Wound closure.

Step 7: Postoperative Care

- Early on, patients were required to remain on bed rest for >4 weeks after we performed vascularized bone-grafting, and some had limitation of hip flexion postoperatively. Currently, patients are allowed to begin hip physical exercise immediately after recovery from anesthesia. This protocol substantially reduced the rate of postoperative stiffness. We performed 6-week postoperative DSA for some patients who underwent vascularized bone-grafting, and we did not find that early hip motion compromised the vascularity of the graft.

Results

The overall outcome of vascularized iliac bone flap transfer was successful in 86% of 226 hips in our study¹². Fourteen hips in 13 patients required conversion to a total hip arthroplasty at a mean of 3 years postoperatively. As compared with all of the patients preoperatively, the patients without hip failure subsequent to vascularized iliac bone flap transfer had a reduction in pain at the time of follow-up although the parameters of range of motion were not improved. Patients with precollapse osteonecrosis or mild collapse of the femoral head had a better outcome than those with more advanced stages. Successful results were found in 94% of the patients who were younger than 45 years of age but in only 62% of those older than 45 years.

Our results suggest that vascularized iliac bone flap transfer combined with autologous cancellous bone impaction as described is not appropriate for patients with advanced stages of osteonecrosis of the femoral head. However, patients who were younger than 45 years old and had no collapse or mild collapse of the femoral head, with integrity of the weight-bearing surface, had satisfying results regardless of the extent of the necrotic lesion.

Pitfalls & Challenges

- It may be difficult to completely remove the necrotic bone during surgery, especially from ARCO stage-IIc or IIIC femoral heads with larger lesions. For these cases, the core area of the necrotic lesion should be debrided. Thus, preoperative evaluation of the necrotic lesion with CT or MRI is crucial.
- After debridement of a large necrotic lesion of the femoral head, insufficient bone implantation and impaction might result in femoral head collapse with postoperative weight-bearing.
- When performing debridement with a high-speed abrasive drill, care should be taken not to “cut out” the subchondral bone and compromise femoral head cartilage. This will more likely happen in cases with a collapsed femoral head (ARCO stage III) in which subchondral fracture already exists.
- Compared with free vascularized fibular grafting techniques, vascularized iliac bone-grafting has the advantages of being less invasive and having low donor site morbidity and low demand for a microsurgical technique because no vascular anastomosis is needed. However, the mechanical support for the femoral head is not as strong as what vascularized fibular grafting can provide.
- Preoperative digital subtraction angiography can be used to evaluate the intraosseous blood supply of the femoral head and the condition of the ALCFVs.

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References

1. Lieberman JR, Engstrom SM, Meneghini RM, SooHoo NF. Which factors influence preservation of the osteonecrotic femoral head? *Clin Orthop Relat Res*. 2012 Feb;470(2):525-34.
2. Mont MA, Cherian JJ, Sierra RJ, Jones LC, Lieberman JR. Nontraumatic osteonecrosis of the femoral head: where do we stand today? A ten-year update. *J Bone Joint Surg Am*. 2015 Oct 7;97(19):1604-27.
3. Mont MA, Jones LC, Hungerford DS. Nontraumatic osteonecrosis of the femoral head: ten years later. *J Bone Joint Surg Am*. 2006 May;88(5):1117-32.
4. Kang P, Pei F, Shen B, Zhou Z, Yang J. Are the results of multiple drilling and alendronate for osteonecrosis of the femoral head better than those of multiple drilling? A pilot study. *Joint Bone Spine*. 2012 Jan;79(1):67-72. Epub 2011 Jul 13.
5. Liu ZH, Guo WS, Li ZR, Cheng LM, Zhang QD, Yue DB, Shi ZC, Wang BL, Sun W, Zhang NF. Porous tantalum rods for treating osteonecrosis of the femoral head. *Genet Mol Res*. 2014 Oct 20;13(4):8342-52.
6. Hamanishi M, Yasunaga Y, Yamasaki T, Mori R, Shoji T, Ochi M. The clinical and radiographic results of intertrochanteric curved varus osteotomy for idiopathic osteonecrosis of the femoral head. *Arch Orthop Trauma Surg*. 2014 Mar;134(3):305-10. Epub 2014 Jan 7.
7. Windisch C, Kolb W, Röhner E, Wagner M, Roth A, Matziolis G, Wagner A. Invasive electromagnetic field treatment in osteonecrosis of the femoral head: a prospective cohort study. *Open Orthop J*. 2014 Jun 13;8:125-9.
8. Gagala J, Tarczyńska M, Gawęda K. Clinical and radiological outcomes of treatment of avascular necrosis of the femoral head using autologous osteochondral transfer (mosaicplasty): preliminary report. *Int Orthop*. 2013 Jul;37(7):1239-44. Epub 2013 May 1.
9. Zhao D, Zhang Y, Wang W, Liu Y, Li Z, Wang B, Yu X. Tantalum rod implantation and vascularized iliac grafting for osteonecrosis of the femoral head. *Orthopedics*. 2013 Jun;36(6):789-95.
10. Zhao D, Wang B, Guo L, Yang L, Tian F. Will a vascularized greater trochanter graft preserve the necrotic femoral head? *Clin Orthop Relat Res*. 2010 May;468(5):1316-24. Epub 2009 Nov 7.
11. Eward WC, Rineer CA, Urbaniak JR, Richard MJ, Ruch DS. The vascularized fibular graft in precollapse osteonecrosis: is long-term hip preservation possible? *Clin Orthop Relat Res*. 2012 Oct;470(10):2819-26. Epub 2012 Jun 26.
12. Zhao D, Xu D, Wang W, Cui X. Iliac graft vascularization for femoral head osteonecrosis. *Clin Orthop Relat Res*. 2006 Jan;442:171-9.