Follow us @BoneJointOpen

Freely available online OPEN ACCESS

BJO

HIP

Surface repair of the femoral head using press-osteochondral autograft transfer

NINE TO 25 YEARS' FOLLOW-UP OF 11 HIPS

C. Passaplan,
M. Hanauer,
L. Gautier,
V. M. Stetzelberger,
J. M. Schwab,
M. Tannast,
E. Gautier

From HFR – Cantonal Hospital, University of Fribourg, Fribourg, Switzerland

Aims

Hyaline cartilage has a low capacity for regeneration. Untreated osteochondral lesions of the femoral head can lead to progressive and symptomatic osteoarthritis of the hip. The purpose of this study is to analyze the clinical and radiological long-term outcome of patients treated with osteochondral autograft transfer. To our knowledge, this study represents a series of osteochondral autograft transfer of the hip with the longest follow-up.

Methods

We retrospectively evaluated 11 hips in 11 patients who underwent osteochondral autograft transfer in our institution between 1996 and 2012. The mean age at the time of surgery was 28.6 years (8 to 45). Outcome measurement included standardized scores and conventional radiographs. Kaplan-Meier survival curve was used to determine the failure of the procedures, with conversion to total hip arthroplasty (THA) defined as the endpoint.

Results

The mean follow-up of patients treated with osteochondral autograft transfer was 18.5 years (9.3 to 24.7). Six patients developed osteoarthritis and had a THA at a mean of 10.3 years (1.1 to 17.3). The cumulative survivorship of the native hips was 91% (95% confidence interval (CI) 74 to 100) at five years, 62% (95% CI 33 to 92) at ten years, and 37% (95% CI 6 to 70) at 20 years.

Conclusion

This is the first study analyzing the long-term results of osteochondral autograft transfer of the femoral head. Although most patients underwent conversion to THA in the long term, over half of them survived more than ten years. Osteochondral autograft transfer could be a time-saving procedure for young patients with devastating hip conditions who have virtually no other surgical options. A larger series or a similar matched cohort would be necessary to confirm these results which, in view of the heterogeneity of our series, seems difficult to achieve.

Cite this article: *Bone Jt Open* 2023;4-7:523–531.

Keywords: Osteochondral autograft transfer, Cartilage repair, Hyaline cartilage, Hip joint surgery, Reconstruction of articular surface, Surgical hip dislocation

Introduction

Osteochondral defects of the articular surface of the femoral head may result from trauma (e.g. acetabular fracture, Pipkin fracture, hip dislocation), or may occur as part of developmental or metabolic diseases such as femoroacetabular impingement (FAI), acetabular dysplasia, avascular necrosis (AVN), Perthes' disease (PD), osteochondritis dissecans, and slipped capital femoral epiphysis. These defects cause disruption to the hyaline cartilage layer, which has a limited capacity to heal. When healing does occur, fibrocartilage is produced, which does not offer the same biological and mechanical properties compared to hyaline cartilage. Because of

Correspondence should be sent to Caroline Passaplan; email: caroline.passaplan@gmail.com

doi: 10.1302/2633-1462.47.BJO-2022-0137.R1

Bone Jt Open 2023;4-7:523–531.

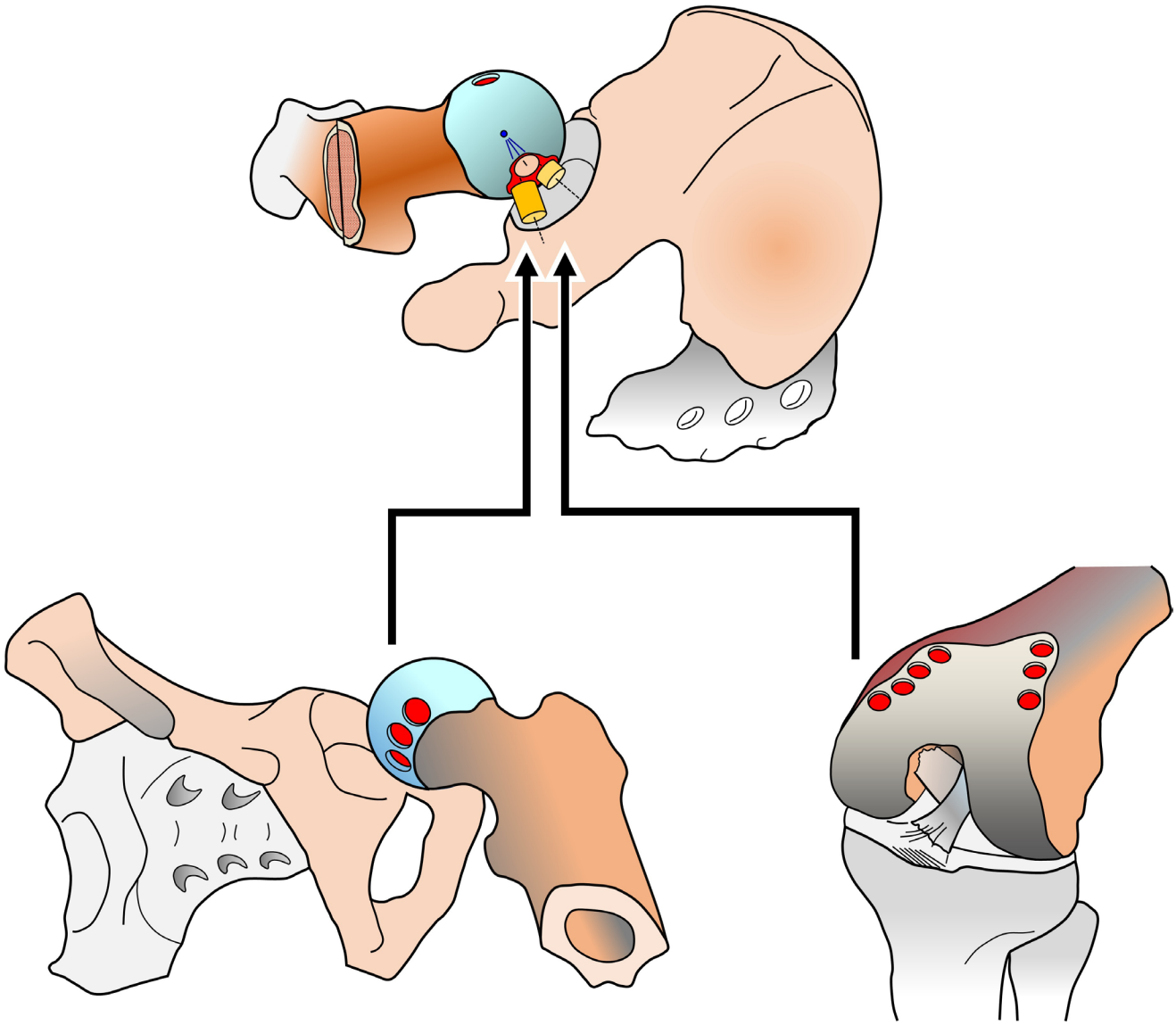

Fig. 1

Harvesting and transplantation of grafts. Osteochondral autografts are harvested either from the anteroinferior parts of the ipsilateral femoral head or from the femoral trochlea of the ipsilateral knee. For precise harvesting from the inferior head, the surgeon should stand in front of the patient. For precise insertion of the transplants, the surgeon has to move towards the back (i.e. at the dorsal side) of the patient.

the limited healing capacity, surgical reconstruction of the articular surface is indicated in young patients presenting with a localized osteochondral lesion of the weightbearing zone of the femoral head. The goal of the surgical reconstruction is to restore joint congruity and, whenever possible, postpone progression of the hip to osteoarthritis.[1] Common techniques for surgical reconstruction include bone marrow stimulation, autologous chondrocyte implantation,[2] or osteochondral auto- or allograft transfer (OAT).[3] An additional treatment option is proximal femoral osteotomy, which does not directly address the lesion, but rather moves the lesion out of the weightbearing zone of the hip.[4]

The principle of OAT is to fill an osteochondral defect with one or more osteochondral plugs in order to recreate a congruent articular surface composed mainly of hyaline cartilage. OAT has been successfully used in the knee and the ankle joint. When performing OAT on the hip joint, multiple options for source plugs are available, including the distal femoral condyles,[5–14] allografts,[15-19] or hip-to-hip plug transfer.[3,20-24] Autografts harvested from the distal femoral condyles are associated with donor site morbidity.[25]

In our institution, we have used OAT in the hip since 1996. The purpose of this study is to evaluate the

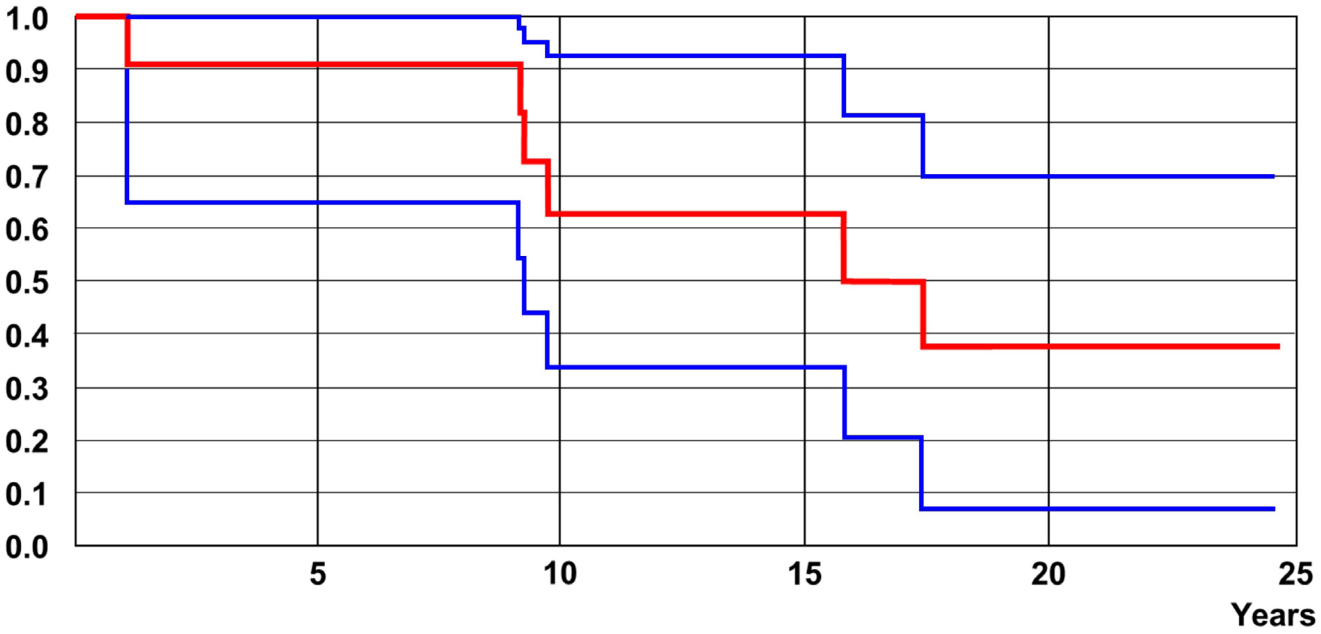

Fig. 2

Kaplan-Meier survivorship. Cumulative survivorship of the native hips at five years was 91% (95% confidence interval (CI) 74 to 100), at ten years was 62% (95% CI 33 to 92), and at 20 years 37% (95% CI 6 to 70). Blue lines indicate the CIs.

Table I. Demographics of patients.

Patient	Age, yrs	Sex	Side	Pathology	Approach	Additional surgery	Endpoint THA, yrs	Follow-up, yrs
1	29.4	M	L	AVN IIA	KL-Flip			23.8
2	27.2	F	L	AVN IIB	KL-Flip	Labral resection		13.7
3	22.0	F	L	AVN IIB	KL-Flip			9.3
4	34.1	M	L	AVN III	Smith-Petersen	Periacetabular osteotomy	9.2	
5	19.7	F	L	AVN III	Smith-Petersen		9.7	
6	8.4	M	R	Perthes	Smith-Petersen, Ludloff	Triple osteotomy		24.7
7	31.2	M	L	FAI	KL-Flip		9.1	
8	44.7	F	L	FAI	KL-Flip		1.1	
9	21.5	M	L	Both column	KL Flip, ilioinguinal	ORIF		20.9
10	39.8	M	L	Posterior wall	KL-Flip	ORIF	17.3	
11	36.5	M	L	Dislocation	KL-Flip		15.7	
Total		7 M	1 R		8 KL-Flip			
		4 F	10 L		3 Smith-Petersen			

AVN, avascular necrosis; FAI, femoroacetabular impingement; KL-Flip, Kocher-Langenbeck approach with trochanteric flip osteotomy; L, left; R, right; THA, total hip arthroplasty.

long-term outcome of all patients treated for an osteochondral lesion of the femoral head using OAT.

Methods

Patients. Overall, 11 patients who underwent OAT for chondral or osteochondral defects of the femoral head between September 1996 and August 2012 were included in this study. All patients provided written informed consent for the use of their data and images for this study. No patient was lost to follow-up. Patients with a follow-up of less than five years, or inability to give written consent for participation in the study, were excluded from our analysis. Data collection of this retrospective study included age, sex, aetiology, size of osteochondral defect, number of plugs harvested, length of follow-up, clinical and radiological outcomes, complications, and need for further surgery. Conversion to total hip arthroplasty (THA) was designated as the endpoint of the study.

The mean age at surgery was 28.6 years (8.4 to 44.7). There was a preponderance of male patients (7 males, 4 females). Ten affected hips were on the left side; one was on the right. Conversion to THA occurred in six patients at a mean of 10.3 years (1.1 to 17.3) after the index procedure. The five patients who had not undergone

Table II. Defect size, number, and diameter of the osteochondral grafts.

Patient	Defect area, mm²	Total area replaced		Number of grafts with corresponding diameters and surface areas				
		mm²	%	D = 7.45 mm A = 43.6 mm²	D = 6.40 mm A = 32.2 mm²	D = 5.50 mm A = 23.8 mm²	Total number	Donor site
1	236	161	68		5		5	Knee
2	141	97	68		3		3	Hip
3	825	97	12		3		3	Hip
4	491	193	39		6		6	Knee
5	825	420	51	8		3	11	Knee
6	491	71	15			3	3	Knee
7	188	131	69	3			3	Hip
8	314	97	31		3		3	Hip
9	118	97	82		3		3	Hip
10	353	290	82		9		9	Knee
11	346	131	38	3			3	Hip
Total				14	32	6	52	5 Knee 6 Hip

A, surface area of graft; D, diameter of graft.

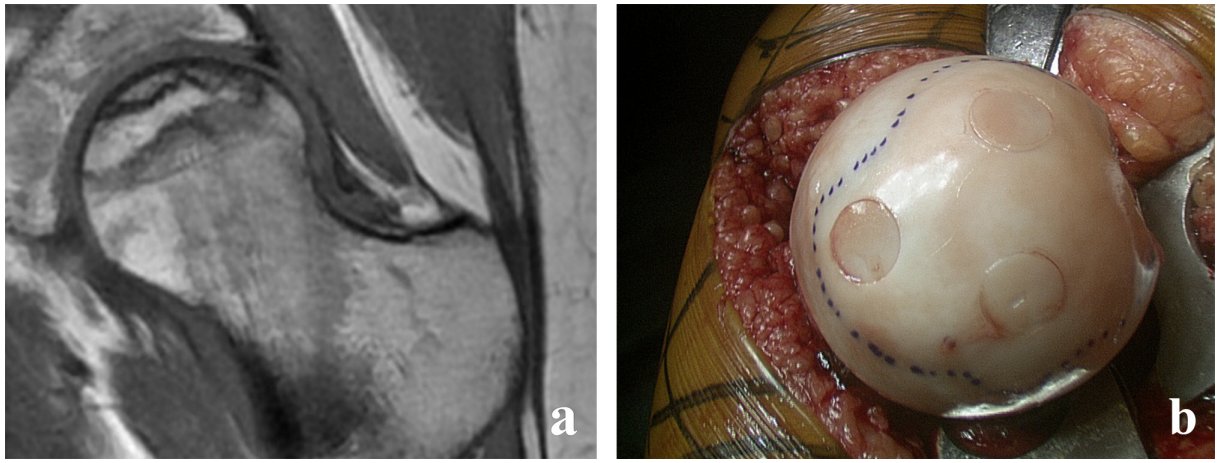

Fig. 3

a) Preoperative coronal MRI of a 22-year-old female patient with lupus erythematosus presenting with stage IIB avascular necrosis of the femoral head. b) Intraoperative view showing the stabilization of the necrotic area with careful implantation of three hip-to-hip transplants.

conversion to THA were followed up at a mean of 18.5 years (9.3 to 24.7), with mean age at follow-up 40.2 years (31.3 to 53.2) (Table I).

The aetiology or underlying condition that resulted in the osteochondral defect was identified for all patients. Five patients had AVN of the femoral head, two developed cartilaginous defects as a sequelae of FAI, and one due to PD. Three patients had a traumatic lesion of the femoral head. Two were associated with an acetabular fracture, and one with an incarcerated posterior hip dislocation.

Surgical technique. The senior author (EG) performed all surgeries. Eight patients underwent surgical hip dislocation with trochanteric flip osteotomy in the lateral decubitus position via a Kocher-Langenbeck approach.[26,27] Three patients were operated in the supine position using a standard Smith-Petersen approach with anterior surgical hip dislocation.[28]

Intraoperatively, we measured the area of the defect. Osteochondral plugs were harvested from the inferior segment of the femoral head (six patients), or from the femoral trochlea (five patients; Figure 1).

Additional procedures were performed on eight patients. These included partial labral resection (four patients), trimming of the acetabular rim (one patient), femoral osteochondroplasty (three patients), open reduction and internal fixation (ORIF; two patients), periacetabular osteotomy (PAO; one patient), and triple pelvic osteotomy (one patient). Some additional procedures necessitated additional surgical approaches, including

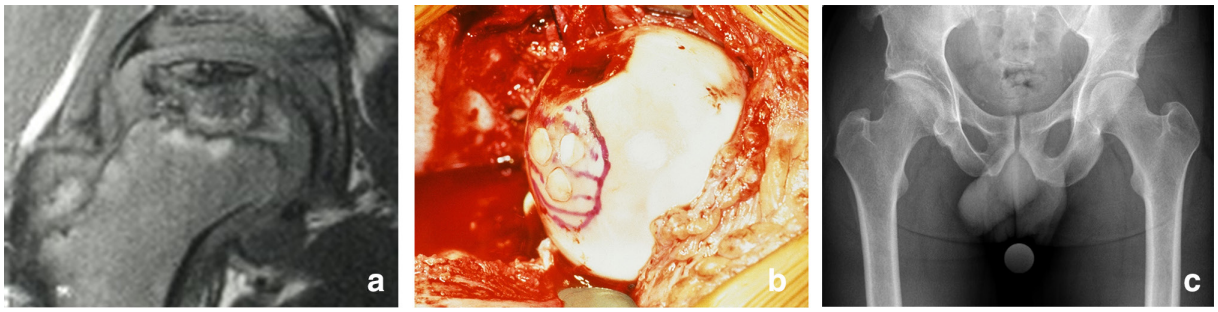

Fig. 4

a) Eight-year-old male patient with Perthes' disease. Coronal MRI indicating the extent of the necrosis as well as a slight lateral extrusion of the femoral head. b) Intraoperative view showing the stabilization of the necrotic area with three osteochondral autografts taken from the ipsilateral knee joint. c) Anteroposterior pelvis views of the same patient at last follow-up, 24.7 years after the index procedure, shows a clinical and radiologically normal right hip joint.

the Ludloff approach (two patients)[29] and ilioinguinal approach (one patient).

Postoperative regimen included touchdown weightbearing (1/6 body weight, or 10 to 15 kg) of the involved limb for six weeks. Radiological assessments were performed at six weeks, and progressive weightbearing was allowed when uneventful healing of the greater trochanter was visible. Patients with pelvic osteotomies or ORIF had additional radiographs at three months, and were allowed to fully bear weight when healing of the innominate bone was noted.

Assessment at follow-up. We performed a thorough standardized clinical examination in all patients who had not undergone conversion to THA. The clinical examination included gait assessment, presence of a limp, hip range of motion, leg length assessment, hip abductor force, and impingement testing.

Outcome measures, including Merle d'Aubigné Score (mMdA),[30,31] Harris Hip Score (mHHS),[32] Hip disability and Osteoarthritis Outcome Score (HOOS),[33,34] University of California Los Angeles Activity Score (UCLA),[35] and Western Ontario McMaster Universities Osteoarthritis Index (WOMAC)[36] were collected. Radiological evaluation included a supine anteroposterior pelvis and cross-table axial view. Heterotopic ossifications was classified according to Brooker et al,[37] and osteoarthritis according to Tönnis and Heinecke.[38]

Statistical analysis. Statistical analysis was conducted with SPSS version 26.0 (IBM, USA). Kaplan-Meier survival analysis was used to determine the failure of the OAT procedure with conversion to THA as the endpoint.

Results

The cumulative survivorship at five years was 91% (95% confidence interval (CI) 74 to 100), at ten years was 62% (95% CI 33 to 92), and at 20 years was 37% (95% CI 6 to 70; Figure 2).

At follow-up, the mean mMdA was 15.8 (14 to 18), mean mHHS was 71.7 (40.5 to 97), mean HOOS was 72.3 (45.6 to 99.4), mean UCLA was 5.2 (3 to 7), and mean WOMAC was 68.6 (43.8 to 100).

There were no surgery-related complications including infection, nerve or vascular injuries, or trochanteric nonunion. In addition, no medical complications such as thromboembolic disease were documented. Of the five patients where plugs were taken at the knee, none complained of donor site pain.

The mean defect size of the femoral head, as measured intraoperatively, was 3.9 cm^2 (1.2 to 8.3). In two patients whose underlying diagnosis was FAI, an additional full-thickness cartilaginous defect of the superolateral acetabulum was identified measuring 1.1 and 2.4 cm^2, respectively. To reconstruct the articular surface, between three and 11 grafts were transferred with diameters of 5.50, 6.40, or 7.45 mm. Grafts were taken from the ipsilateral knee when more than three plugs were needed for repair, as well as in one patient with PD in order to avoid harming the open proximal femoral growth plate. Once the plugs were placed, a mean 1.6 cm^2 (0.7 to 4.2) of articular surface was reconstructed, corresponding to 51% (12% to 82%) of the area of the initial defect (Table II).

At follow-up, two of the five patients who had not been converted to THA reported poor hip function, discomfort in activities of daily living, and pain. One of these patients presented more than 24 years after the index operation and demonstrated severe radiological osteoarthritis. The second patient, presenting 9.3 years the index operation, had been diagnosed with systemic lupus erythematosus. This patient demonstrated AVN of the opposite hip and bilateral AVN of the femoral condyles (Figure 3). One patient, who presented at eight years of age with PD and an osteochondral defect, was treated with OAT and triple pelvic osteotomy. This patient developed secondary FAI and underwent a second surgical hip dislocation 7.5 years after the index procedure. At 24.8 years' follow-up (Figure 4), this patient presented with an excellent result. In addition, two patients showed radiological

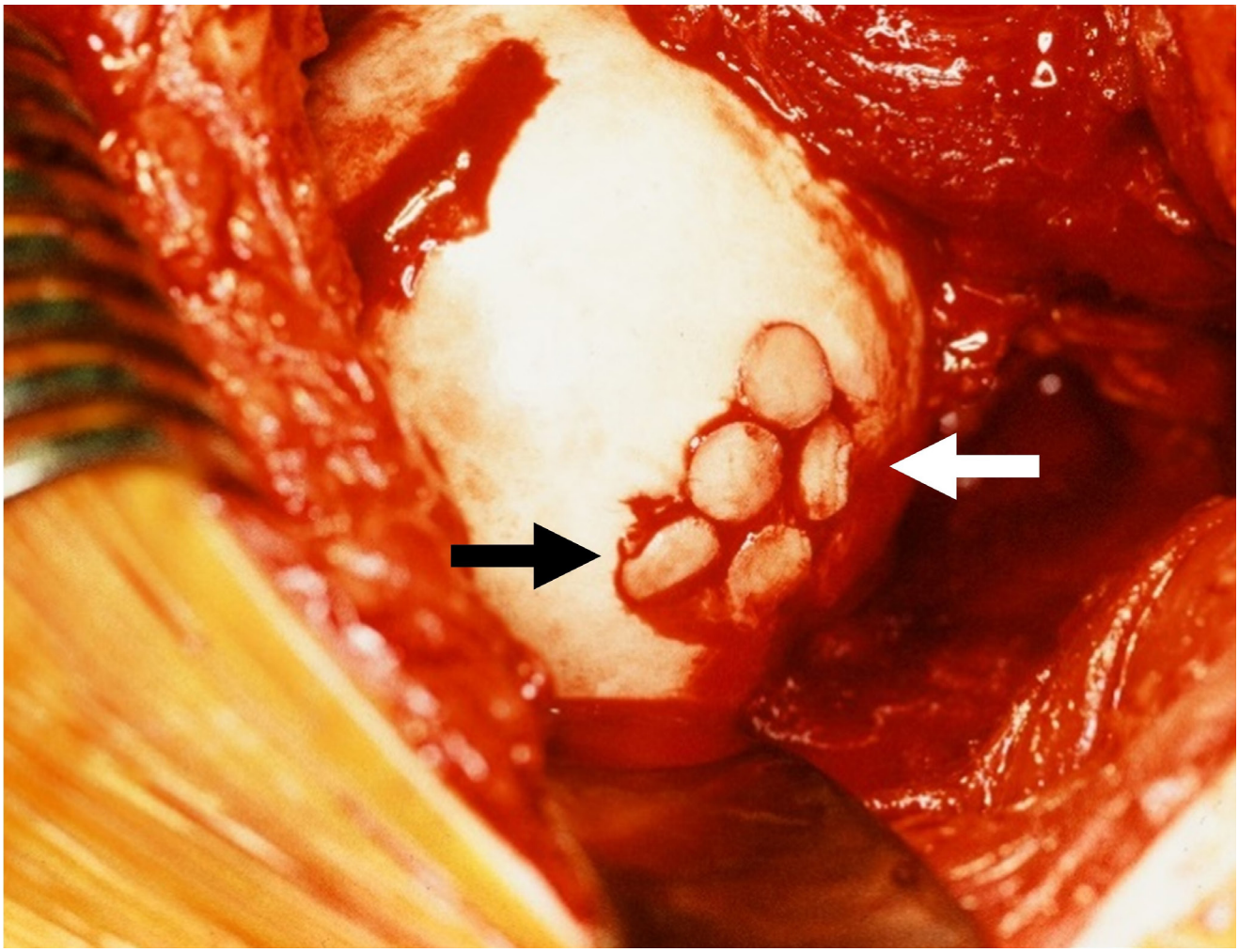

Fig. 5

A 29-year-old male patient with stage IIA avascular necrosis of the femoral head treated with osteochondral auto- or allograft transfer (OAT). The grafts were taken from the ipsilateral knee joint. In knee-to-hip transfer, perfect reconstruction is difficult to obtain from a technical perspective. The intraoperative view shows an incongruous femoral head surface due to incorrect placement of two grafts (arrows). At 23.8 years' follow-up, this patient had not undergone conversion to THA.

osteoarthritis > Tönnis grade I, and one patient demonstrated Brooker class II heterotopic ossification.

Discussion

In our series of 11 patients, six (55%) underwent conversion to a THA at a mean of 10.3 years after the index OAT surgery. The five patients who maintained their native hips were evaluated at a mean of 18.5 years. Survivorship at ten years was calculated to be 62.3% dropping down to 37.4% at 20 years. Follow-up mean outcome scores revealed mMdA to be good (15.8), mHHS to be fair (71.7), HOOS was 72.3, UCLA was 5.2, and WOMAC was 68.8.

For patients undergoing conversion to THA, we identified major risk factors as AVN stage III or greater, or additional cartilaginous lesions of the acetabulum. Two patients with AVN stage III were converted to THA at 9.2 and 9.7 years, respectively. Two patients with FAI and concomitant cartilage defects of the superolateral acetabulum underwent conversion to THA at 1.1 and 9.1 years, respectively. Two of three patients having traumatic damage to the femoral head were converted to THA at 15.7 and 17.3 years. Given the small size and heterogeneity of our series, as well as a lack of a matched comparison group, we cannot definitively conclude that these represent the most important risk factors.

Conversion to THA was necessary in three (60%) of the five patients whose plugs were harvested from the ipsilateral knee. By contrast, two (33%) out of the six patient whose plugs were harvested from the inferior femoral head were converted to THA. This may underline the importance of restoring a perfect congruity of the joint. When harvesting the grafts from the knee, some plugs have to be taken at different angles with regard to

Table III. Review of the literature: case reports.

Author	Year	Cases	Approach	Donor site	Plugs	Defect size	Follow-up, mths	Conversion to THA
Hart et al[5]	2003	1	KL-Flip	Knee	4	14 mm	60	NR
Weisz[39]	2006	1	KL-Flip	Knee	3	10 × 33 mm	48	0
Sotereanos et al[20]	2008	1	KL-Flip	Hip	3	15 mm	66	0
Evans and Providence[15]	2010	1	KL-Flip	Allograft	1	25 × 25 mm	12	0
Nam et al[3]	2010	1	KL-Flip	Knee	3	20 × 8 mm	12	0
		1	KL-Flip	Hip	1	10 mm	60	0
Krych et al[6]	2012	2	KL-Flip	Knee		20 × 8 mm 20 × 20 mm	51	0
Kilicoglu et al[8]	2015	1	KL-Flip	Knee	3/2	NR	96	0
Kubo et al[9]	2015	1	Arthroscopy	Knee	1	8.5 mm	NR	NR
Anthonissen et al[10]	2016	1	KL-Flip	Knee	4	5 cm^2	24	0
Won et al[21]	2016	1	KL-Flip	Hip	1	10 × 25 mm	12	0
Kocedal et al[11]	2017	1	Arthroscopy	Knee	1	10 mm	26	0
Kong[12]	2017	1	KL-Flip	Knee and Hip	4 1	NR	19	0
Uchida et al[13]	2017	2	Arthroscopy	Knee	1	8.5 mm 10 mm	36 12	0 0
Jamali et al[17]	2019	1	KL-Flip	Allograft	3	25 × 25 mm	12	1
Moreau et al[18]	2019	1	KL-Flip	Allograft	1	35 × 32 mm	96	0
Garcia-Mansilla et al[19]	2020	1	KL-Flip	Allograft	1	18 × 24 mm	6	0
Kaymaz et al[23]	2020	1	KL-Flip	Hip	6	20 × 30 mm	18	0
Coulomb et al[14]	2021	1	Hueter	Knee	3	20 × 30 mm	12	0
Palazón-Quevedo et al[24]	2021	2	KL-Flip	Hip	3	20 × 8 mm	48 60	0 0

KL-Flip, Kocher-Langenbeck approach with trochanteric flip osteotomy; NR, not reported; THA, total hip arthroplasty.

Table IV. Review of the literature: case series.

Author	Year	Cases	Approach	Donor site	Plugs	Defect size	Follow-up, mths	Conversion to THA
Rittmeister[40]	2005	5	Hueter	1 × knee, 4 × hip	1 to 3	14 to 90 mm	57	4 (mean 49 mths)
Girard[1]	2011	10	KL-Flip	Hip	NR	4.8 (3 to 9) cm^2	29	0
Gagala[7]	2013	7	KL-Flip	Knee	3 to 5	NR	46	1
		14	KL-Flip	Knee + bone graft	3 to 5	NR	33	5
Kosashvili[16]	2013	8	KL-Flip	Allograft	1	NR	41	1
Johnson[22]	2017	5	KL-Flip	Hip	1 × 1 4 × 3	10 to 40 mm	54	0
Sonnega[41]	2019	4	Arthroscopy	Knee	1	8 mm	NR	0
Viamont-Guerra[42]	2019	27	Hueter	Hip	1 to 8	1.6 (0.8 to 4) cm^2	39	1
Own study	2022	11	KL-Flip SP	Knee or hip	3 to 11 knee-hip 6 × 3 hip-hip	3.9 (1.2 to 8.3) cm^2	168	6

KL-Flip, Kocher-Langenbeck approach with trochanteric flip osteotomy; NR, not reported; SP, Smith-Petersen; THA, total hip arthroplasty.

the cartilaginous surface, making graft orientation and perfect reconstruction of the femoral head more difficult (Figure 5).

Only a few papers show a medium-term follow-up of patients treated with OAT. Many authors report experience with one or two cases and follow-ups of between one and eight years.[3,5,6,8–10,12–15,19–24,39] They are few reports of follow-up on OAT procedures having more than two patients. Rittmeister et al[40] reported disappointing results in patients treated with mosaicplasty for AVN of the femoral head, with four out of five patients requiring a prosthesis at an average of 49 months postoperatively. Girard et al[1] analyzed the short-term clinical and radiological findings in a series of ten patients with a mean follow-up of 29 months. At the latest follow-up, the HHS was 79.5 points and the UCLA score was 5.8. There was

no reported conversion to THA. Gagala et al[7] described a series of seven patients with AVN IIA or B treated with OAT: at a mean follow-up of 46 months, the patients had a HHS of 87.85 points. One conversion to THA was performed at 18 months postoperatively. In a second group of 13 patients (14 hips) with AVN ARCO IIC, III, or IV, OAT was combined with allogenic bone graft. Five patients underwent conversion to THA secondary to head collapse between seven and 12 months following the index procedure. Kosashvili et al[16] reported on a series of eight patients with a mean follow-up of 41 months; one hip was converted to THA. Johnson et al[22] reported on a series of five patients with 4.5 years' follow-up, a mean HHS of 86.6, and no conversion to THA. Sonnega et al[41] performed OAT arthroscopically in four patients with no conversion to THA, though follow-up in this series was limited. Viamont-Guerra et al[42] described the results of 27 patients operated through a Hueter approach. At 39 months' mean follow-up, only one hip was converted to THA. More detailed data of case reports and case series are shown in Tables III and IV.

Our study has some limitations: first, it represents a retrospective study with no control group, and therefore level IV evidence. Second, the different and varied underlying pathologies, in the context of a small number of participants, limit the ability to propose strong conclusions. Third, most patients in this series had additional interventions to OAT related to the different underlying pathologies (e.g. ORIF, PAO). Strengths of our study is the long follow-up, no loss of patients, and a single surgeon's series of patients.

To summarize, OAT is intented to reconstruct damaged articular surface with a layer of hyaline cartilage, and has been established as a reasonable technique for articular surface repair in the knee and the ankle joint. In the hip joint, the procedure is feasible but technically demanding. This study represents one of the longest follow-ups of a series of osteochondral autografts of the femoral head. Although the majority of hips underwent conversion to THA during the long follow-up, over half of the patients survived more than ten years. While a larger series or a similar matched cohort would be necessary for definitive confirmation, we believe OAT is a safe option across a variety of underlying pathologies, and may delay the need for THA conversion.

Take home message

- This is the first study analyzing the long-term results of osteochondral autograft transfer of the femoral head.
- Osteochondral autograft transfer could be a time-saving procedure for young patients with devastating hip conditions.

References

1. **Girard J**, **Roumazeille T**, **Sakr M**, **Migaud H**. Osteochondral mosaicplasty of the femoral head. *Hip Int.* 2011;21(5):542–548.
2. **Akimau P**, **Bhosale A**, **Harrison PE**, **et al**. Autologous chondrocyte implantation with bone grafting for osteochondral defect due to posttraumatic osteonecrosis of the hip--a case report. *Acta Orthop.* 2006;77(2):333–336.
3. **Nam D**, **Shindle MK**, **Buly RL**, **Kelly BT**, **Lorich DG**. Traumatic osteochondral injury of the femoral head treated by mosaicplasty: a report of two cases. *HSS J.* 2010;6(2):228–234.
4. **Yamamoto T**, **Iwasaki K**, **Iwamoto Y**. Transtrochanteric rotational osteotomy for a subchondral insufficiency fracture of the femoral head in young adults. *Clin Orthop Relat Res.* 2010;468(12):3181–3185.
5. **Hart R**, **Janecek M**, **Visna P**, **Bucek P**, **Kocis J**. Mosaicplasty for the treatment of femoral head defect after incorrect resorbable screw insertion. *Arthroscopy.* 2003;19(10):E1–5.
6. **Krych AJ**, **Lorich DG**, **Kelly BT**. Osteochondral autograft transfer for a posttraumatic osteochondral defect of the femoral head. *Am J Orthop (Belle Mead NJ).* 2012;41(10):472–476.
7. **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;37(7):1239–1244.
8. **Kılıçoğlu Öİ**, **Polat G**, **Erşen A**, **Birişik F**. Long-term result of mosaicplasty for femoral head osteochondral lesion: a case report with 8 years follow-up. *Hip Int.* 2015;25(6):589–592.
9. **Kubo T**, **Utsunomiya H**, **Watanuki M**, **Hayashi H**, **Sakai A**, **Uchida S**. Hip arthroscopic osteochondral autologous transplantation for treating osteochondritis dissecans of the femoral head. *Arthrosc Tech.* 2015;4(6):e675–80.
10. **Anthonissen J**, **Rommens PM**, **Hofmann A**. Mosaicplasty for the treatment of a large traumatic osteochondral femoral head lesion: a case report with 2 year follow-up and review of the literature. *Arch Orthop Trauma Surg.* 2016;136(1):41–46.
11. **Kocadal O**, **Akman B**, **Güven M**, **Şaylı U**. Arthroscopic-assisted retrograde mosaicplasty for an osteochondral defect of the femoral head without performing surgical hip dislocation. *SICOT J.* 2017;3:41.
12. **Kong GM**. Osteochondral autograft transplants for femoral head impaction fracture: A case report with arthroscopic findings. *J Clin Orthop Trauma.* 2017;8(Suppl 1):S29–S31.
13. **Uchida S**, **Utsunomiya H**, **Honda E**, **et al**. Arthroscopic osteochondral autologous transplantation for the treatment of osteochondritis dissecans of the femoral head. *SICOT J.* 2017;3:18.
14. **Coulomb R**, **Alrubaie A**, **Haignière V**, **Kouyoumdjian P**. Femoral head mosaicplasty by direct anterior approach for an osteochondral impaction without performing surgical hip dislocation. *SICOT J.* 2021;7:22.
15. **Evans KN**, **Providence BC**. Case report: Fresh-stored osteochondral allograft for treatment of osteochondritis dissecans the femoral head. *Clin Orthop Relat Res.* 2010;468(2):613–618.
16. **Kosashvili Y**, **Raz G**, **Backstein D**, **Lulu OB**, **Gross AE**, **Safir O**. Fresh-stored osteochondral allografts for the treatment of femoral head defects: surgical technique and preliminary results. *Int Orthop.* 2013;37(6):1001–1006.
17. **Jamali AA**, **Rowland D**, **Vandewalker KN**. Extensive recontouring of the femoral head with osteochondral allografting: A case report with histological and microCT analysis. *Case Rep Orthop.* 2019;2019:6956391.
18. **Moreau LC**, **Beauchamp-Chalifour P**, **Belzile EL**, **Dion N**. Eight-year follow-up using a fresh osteochondral allograft for a femoral head chondroblastoma in a 17-year-old patient. *Case Rep Orthop.* 2019;2019:9262190.
19. **Garcia-Mansilla I**, **Jones KJ**, **Sassoon AA**. Surgical hip dislocation and fresh OC allograft transplantation for FAI and concomitant Chondral lesion. *Arthroscop Tech.* 2020;9:1857–1863.
20. **Sotereanos NG**, **DeMeo PJ**, **Hughes TB**, **Bargiotas K**, **Wohlrab D**. Autogenous osteochondral transfer in the femoral head after osteonecrosis. *Orthopedics.* 2008;31(2):177.
21. **Won Y**, **Lee GS**, **Kim SB**, **Kim SJ**, **Yang KH**. Osteochondral autograft from the ipsilateral femoral head by surgical dislocation for treatment of femoral head fracture dislocation: A case report. *Yonsei Med J.* 2016;57(6):1527–1530.
22. **Johnson JD**, **Desy NM**, **Sierra RJ**. Ipsilateral femoral head osteochondral transfers for osteochondral defects of the femoral head. *J Hip Preserv Surg.* 2017;4(3):231–239.
23. **Kaymaz B**, **Bakırcıoğlu S**, **Yılmaz G**, **Atay ÖA**, **Aksoy MC**. Osteochondral autograft transplantation of the femoral head in sequelae of developmental dysplasia of hip: A case report and review of the literature. *Jt Dis Relat Surg.* 2020;31(3):619–625.
24. **Palazón-Quevedo Á**, **Galán-Olleros M**, **Egea-Gámez RM**. Bilateral femoral head reshaping and mosaicplasty in Legg-Calvé-Perthes disease residual deformity. *J Hip Preserv Surg.* 2021;8(Suppl 1):i9–i15.

25. **Andrade R**, **Vasta S**, **Pereira R**, **et al**. Knee donor-site morbidity after mosaicplasty - a systematic review. *J Exp Orthop*. 2016;3(1):31.
26. **Ganz R**, **Gill TJ**, **Gautier E**, **Ganz K**, **Krügel N**, **Berlemann U**. Surgical dislocation of the adult hip - a technique with full access to the femoral head and acetabulum without the risk of avascular necrosis. *J Bone Joint Surg Br*. 2001;83-B(8):1119–1124.
27. **Gautier E**, **Ganz K**, **Krügel N**, **Gill T**, **Ganz R**. Anatomy of the medial femoral circumflex artery and its surgical implications. *J Bone Joint Surg Br*. 2000;82-B(5):679–683.
28. **Smith-Petersen MN**. Evolution of mould arthroplasty of the hip joint. *J Bone Joint Surg Br*. 1948;30-B(1):59–75.
29. **Hoppenfeld S**, **de Boer P**, **Buckley R**. *Surgical Exposures in Orthopaedics: The Anatomic Approach*. Fifth edition. Wolters Kluwer.
30. **D'Aubigne RM**, **Postel M**. Functional results of hip arthroplasty with acrylic prosthesis. *J Bone Joint Surg Am*. 1954;36-A(3):451–475.
31. **Matta JM**, **Mehne DK**, **Rom R**. Fractures of the acetabulum. *Clin Orthop Relat Res*. 1986;205:241.
32. **Harris WH**. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *J Bone Joint Surg Am*. 1969;51-A(4):737–755.
33. **Klässbo M**, **Larsson E**, **Mannevik E**. Hip disability and osteoarthritis outcome score. An extension of the Western Ontario and McMaster Universities Osteoarthritis Index. *Scand J Rheumatol*. 2003;32(1):46–51.
34. **Nilsdotter AK**, **Lohmander LS**, **Klässbo M**, **Roos EM**. Hip disability and osteoarthritis outcome score (HOOS)--validity and responsiveness in total hip replacement. *BMC Musculoskelet Disord*. 2003;4:10–17.
35. **Zahiri CA**, **Schmalzried TP**, **Szuszczewicz ES**, **Amstutz HC**. Assessing activity in joint replacement patients. *J Arthroplasty*. 1998;13(8):890–895.
36. **Bellamy N**, **Buchanan WW**, **Goldsmith CH**, **Campbell J**, **Stitt LW**. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. *J Rheumatol*. 1988;15(12):1833–1840.
37. **Brooker AF**, **Bowerman JW**, **Robinson RA**, **Riley LH**. Ectopic ossification following total hip replacement. Incidence and a method of classification. *J Bone Joint Surg Am*. 1973;55-A(8):1629–1632.
38. **Tönnis D**, **Heinecke A**. Acetabular and femoral anteversion: relationship with osteoarthritis of the hip. *J Bone Joint Surg Am*. 1999;81(12):1747–1770.
39. **Weisz MA**. Focal osteochondral necrosis of the femoral head of an adult after Legg-Calve-Perthes disease in childhood. *Z Orthop Ihre Grenzgeb*. 2006;144(4):427–431.
40. **Rittmeister M**, **Hochmuth K**, **Kriener S**, **Richolt J**. Five-year results following autogenous osteochondral transplantation to the femoral head. *Orthopade*. 2005;34(4):320.
41. **Sonnega RJA**, **van Susante JLC**, **de Visser E**. A technique for arthroscopic osteochondral autograft transplantation of the hip. *Arthrosc Tech*. 2019;8(2):e101–e104.
42. **Viamont-Guerra MR**, **Bonin N**, **May O**, **Le Viguelloux A**, **Saffarini M**, **Laude F**. Promising outcomes of hip mosaicplasty by minimally invasive anterior approach using osteochondral autografts from the ipsilateral femoral head. *Knee Surg Sports Traumatol Arthrosc*. 2020;28(3):767–776.

Author information:
- C. Passaplan, MD, Orthopaedic Surgeon
- M. Hanauer, MD, Orthopaedic Surgeon
- V. M. Stetzelberger, MD, Orthopaedic Surgeon
- J. M. Schwab, MD, Senior Physician, Orthopaedic Surgeon
- M. Tannast, MD, Professor of Orthopaedic Surgery and Traumatology
- E. Gautier, MD, Professor of Orthopaedic Surgery and Traumatology
  Department of Orthopaedic Surgery, HFR – Cantonal Hospital, University of Fribourg, Fribourg, Switzerland.
- L. Gautier, MD, Consultant in Emergency Medicine, Orthopaedic Surgeon, Emergency Department, Stadtspital Triemli, Zürich, Switzerland.

Author contributions:
- C. Passaplan: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft.
- M. Hanauer: Investigation, Formal analysis, Writing – review & editing.
- L. Gautier: Formal analysis.
- V. M. Stetzelberger: Formal analysis.
- J. M. Schwab: Formal analysis, Supervision, Writing – review & editing.
- M. Tannast: Formal analysis, Supervision, Writing – review & editing.
- E. Gautier: Conceptualization, Methodology, Investigation, Formal analysis, Supervision, Writing – review & editing.

Funding statement:
- The authors disclose receipt of the following financial or material support for the research, authorship, and/or publication of this article: this work has been supported by the Ortho Trauma Foundation and the HFR Research Fund.

ICMJE COI statement:
- M. Tannast reports institutional research support grants from Fribourg Hospital HFR, and consulting fees from DePuy Synthes, unrelated to this study.

Data sharing:
- All data generated or analyzed during this study are included in the published article and/or in the supplementary material.

Ethical review statement:
- The Regional Ethical Committee for Medical and Health Research approved this study (Project-ID: CER-VD 2021-01008), and written informed consent was obtained from all the participants.

Open access funding:
- The open access fee for this study was provided by institutional research support grants from Fribourg Hospital HFR.