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Surgical Treatment of Osteonecrosis of the Femoral Head Using Minimally Invasive Surgical Drilling and Cancellous Grafting at Brazzaville University Hospital

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Abstract

Introduction: Osteonecrosis of the femoral head (ONTF) is a debilitating condition. Several treatments have been proposed with controversial results. The aim of our study was to evaluate treatment by surgical drilling coupled with in situ cancellous grafting. Materials and methods: Our study was a case-control study conducted at Brazzaville University Hospital from 1st January 2018 to 31 December 2023. It compared two groups of patients with ONTF: non-operated (13 patients, 20 hips) and operated (22 patients, 35 hips). We used the visual digital scale (VDS) for pain assessment, the Merle D'Aubigne-Postel (MDP) scoring system for clinical and functional assessment, and the evolution of necrosis. Results: The group of non-operated patients had a mean age of 35.69 ± 3.4 years, no improvement in pain with an EVN above seven at the last recoil and a mean global MDP score falling from 12.7 before offloading to 10.13 at one year. The group of patients operated on had a mean age of 37.86 ± 7.02 years, a significant reduction in pain ($p = 0.00004$) and a significantly increased MDP score ($p = 0.0034$). A comparison of the two groups of patients showed significant stabilization of the necrotic lesions in the operated patients ($p = 0.00067$), with better satisfaction in the same group. Conclusion: Surgical drilling combined with grafting in the treatment of early-stage ONTF has improved progress in our series. The technique is reproducible and less invasive. It has made it possible to delay unfavorable progression and, consequently, hip replacement surgery.

Keywords

Hip, Osteonecrosis of the Femoral Head, Conservative Treatment, Surgical Drilling, Bone Grafting

1. Introduction

Osteonecrosis of the femoral head (ONTF) is a debilitating degenerative complication of the hip. It is explained by a disturbance in vascular perfusion followed by necrosis of the bone below the articular surface [1] [2]. It leads to the collapse of part of the subchondral bone of the femoral head and, subsequently, to osteoarthritis of the hip [1]. Sickle cell disease is the leading aetiology in high-risk regions, with a frequency of 30% - 40% in adolescent and adult patients [3] [4] [5]. In Brazzaville, Republic of Congo, the prevalence of ONTF in sickle cell patients is 0.7% [6]. Other aetiologies and risk factors include thalassemia, chronic alcoholism, long-term corticosteroid therapy, metabolic diseases such as gout, hyperlipidemia, and thrombophilia [7]. In 30% of cases, osteonecrosis is said to be "idiopathic", with no known cause [8]. Many treatments have been proposed in the literature, including drug therapy, offloading, surgical drilling (either simple or combined with a graft), osteotomies and total hip arthroplasty [9] [10] [11]. Surgical drilling, which is a conservative therapeutic technique with controversial efficacy [12], remains a simple therapeutic solution for ONTF in the early stages, particularly in low-income countries. We report our experience of surgical management of this condition using drilling and in situ cancellous bone grafting.

2. Materials and Methods

Our case-control study was conducted at the Brazzaville University Hospital, in the orthopaedic and traumatological surgery department. It was conducted from 1er January 2018 to 31 December 2023, *i.e.* for five years. Patients presented with hip pain associated or not with functional impotence of the pelvic limb with loss of sphericity of the femoral head on X-ray. Additional work-up included computed tomography (CT) or magnetic resonance imaging (MRI). Lesions were classified according to the Ficat and Arlet classification [13] and adapted according to imaging to the A. R. C. O. (Association Research Circulation Osseous) classification [14]. We included all patients with ONTF classified as type I, II or III without subchondral fracture depression. The Koo index [15] was calculated in 11 patients who had obtained an MRI to calculate the extension of the necrotic zone defined as a criterion of severity. The patients were divided into two groups:

- Thirteen patients were not operated on (20 hips) because they refused surgery, were unprepared, were in poor general condition, or had contraindications to surgery;

- Twenty-two patients (35 hips) underwent surgical drilling with cancellous grafting.

The non operated patients were treated with transient offloading and crutching for three months. Axillary crutches were prescribed to better relieve the weight of the body on the hips. They had received pain medication in progressive steps based on the intensity of the pain. The patients operated on underwent percutaneous drilling using the technique of Ficat *et al.* [16] coupled with an in situ cancellous graft. The operation was performed under general anesthaesia or spinal anesthesia. Patients were positioned on a standard surgical table. After identifying the area of necrosis using an image intensifier, a threaded pin was inserted through a small lateral subtrochanteric incision in the thigh (**Figure 1**). Proper centering of the threaded pin was facilitated by external maneuvering of the pelvic limb by a surgeon's assistant. Extra-articular bone drilling was a single operation, performed with a cannulated auger following the cervical and cephalic path, reaching the area of necrosis without ever crossing the joint space (**Figure 2**). An anatomopathological analysis of the drilling product was carried out on eight patients and confirmed the existence of bone and medullary necrosis. A 4 mm cylindrical cancellous bone graft was harvested from the homolateral iliac crest through a 5 mm diameter trocar (**Figure 3** and **Figure 4**), and then introduced into the cervical and cephalic tract as far as the subchondral region using a graft chaser passed through the trocar (**Figure 5**). Depending on the indication, bilateral drilling could be performed during the same operation. A six-week off-loading period and hip mobilization were prescribed post-operatively. The study variables were epidemiological (age, gender, diagnosis

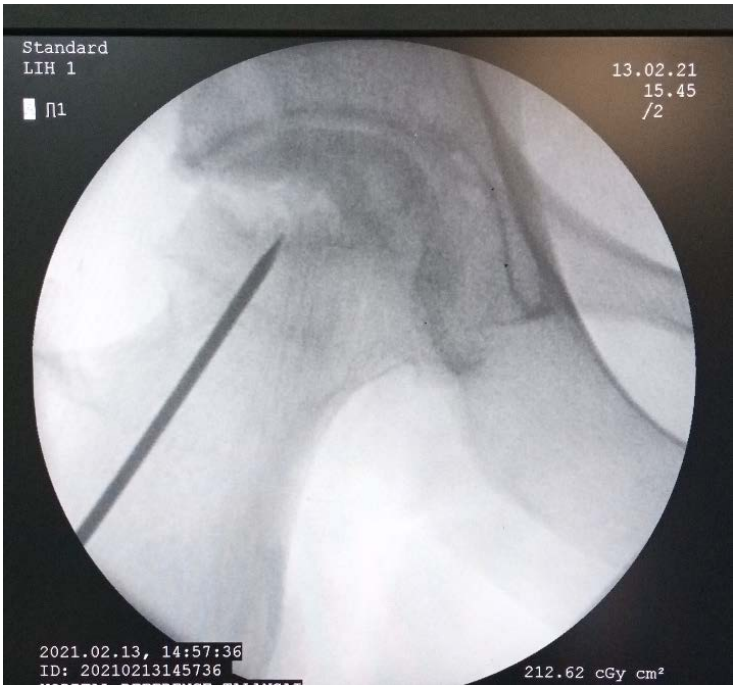
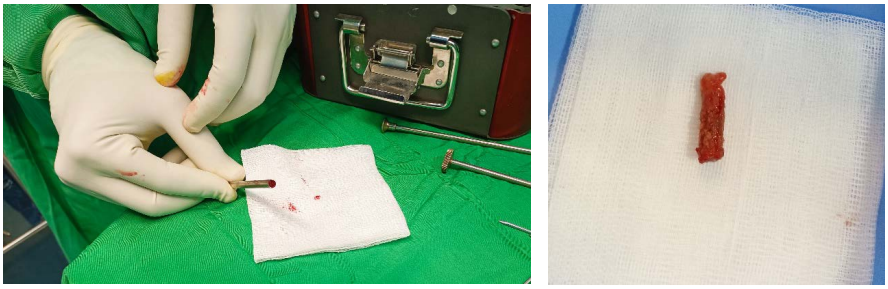


Figure 1. Marking the area of necrosis with a threaded pin.

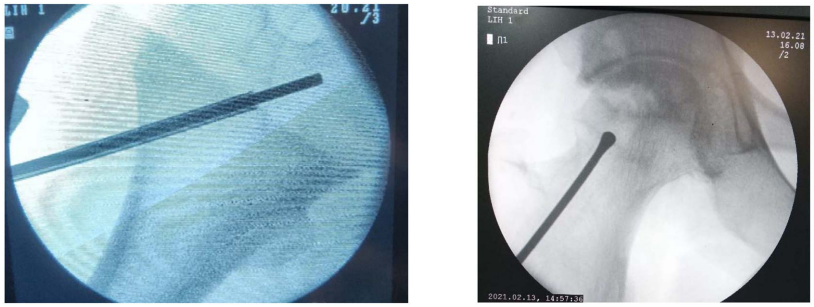
Figure 2. Single hole drilled with an 8 mm cannulated auger.

Figure 3. Harvesting a cancellous graft from the homolateral iliac crest.



(a) (b)

Figure 4. 4 mm diameter cylindrical autologous cancellous graft: (a) cancellous graft harvested from the trocar; (b) cylindrical cancellous graft.



(a) (b)

Figure 5. Positioning of the graft in the cervicocephalic drill tunnel (a) Positioning in the subchondral zone. (b) Impaction of the graft using a graft-driver.

time), clinical and paraclinical (body mass index, laterality, visual numerical scale, function, stage of necrosis), therapeutic (follow-up period, treatment satisfaction) and evolutionary (stage of necrosis, Koo index). Clinical evaluation of the treatment was based on a visual numerical scale (VNS) for pain before and six weeks after treatment: from 0 (minimum) to 10 (maximum). Function was assessed using the Merle D'Aubigne-Postel (MDP) score before treatment and at one year [17]. Cure was considered to have occurred in patients with no pain at six weeks, and with non-progressive images of sclerosis or bone condensation on radiography. At the longest follow-up, treatment failure was declared in patients with persistent pain and functional impairment who required hip replacement surgery within two years. Informed patient consent and ethical and administrative clearances were obtained prior to data collection. Statistical analysis used the Student-Fischer t-test for comparison of means and the χ^2 test corrected by the Yates formula for comparison of rates, unless otherwise stated. Windows Excel and SPSS 19.0 were used to process the data. When the data showed an abnormal distribution and the t-test could not be used, the Mann-Whitney test was applied. A p-value of less than 0.05 was used as the threshold for statistical significance.

3. Results

3.1. Epidemiology

During the study period, we noted (Table 1):

- Thirteen non-operated patients (19 hips), including nine men and four women, giving a M/F sex ratio of 2.25. Six lesions were bilateral and seven unilateral. The aetiology was homozygous sickle cell disease in five patients. The mean age of the patients was 35.69 ± 3.4 years. The time to diagnosis was 2.84 ± 0.98 months and the time to follow-up was 20.38 ± 8.2 months.
- Twenty-two patients underwent surgery (35 hips), 10 men and 12 women, giving an M/F sex ratio of 0.83. The mean age of the patients was 37.86 ± 7.02 years. Fifteen lesions were bilateral and five were unilateral. The aetiology was homozygous sickle cell disease in ten patients. The time to diagnosis was 10.22 ± 4.08 months and the time to follow-up was 16.45 ± 9.7 months.

Table 1. Overall series.

	Not operated (N = 13)	Operated (N = 22)	Value of p
Age	35.69 ± 3.4 years	37.86 ± 7.02 years	0.01
Gender			
Men	9	10	NS
Women	4	12	NS
Etiologies/Risk factors			
Sickle cell disease SS	5	10	NS
Alcohol	3	5	NS
Corticoids	3	6	NS
Idiopathic	2	1	NS
Bilaterality	6	15	NS
Unilaterality	7	5	NS
Body mass index (Kg/m^2)	24.91 ± 2.77	23.41 ± 1.43	0.007
Diagnosis time (months)	2.84 ± 0.98	10.22 ± 4.08	0.0001
Follow-up period (months)	20.38 ± 8.2	16.45 ± 9.7	NS
Satisfaction			
Very satisfied	0	18	NS
Satisfied	11	2	NS
Not satisfied	2	2	NS

NS: Not Significant.

3.2. Clinic

In the group of patients who did not undergo surgery, pain was rated at five for 12 hips (63.15%) and eight for four hips (21.05%). At the last follow-up, pain was rated as seven for 14 hips (73.68%) and nine for three hips (15.78%). In the group of patients who underwent surgery, pain before surgery was rated at seven for seven hips (20%), nine for 18 hips (51.42%) and 10 for six hips (17.14%). After surgery, pain was rated at three for 27 hips (77.14%) and one for six hips (17.14%). The reduction in pain was significant in the operated group (p = 0.00004).

The overall MDP score was 12.7 before offloading and 10.13 at one year in the group of non-operated patients. It was 13.42 before surgery and 15.51 at one year in the operated group. The overall MDP score was significantly higher in the operated group than in the non-operated group (p = 0.0034).

3.3. Evolution of the Necrosis Stage

In the non-operated patients, of the 19 hips affected: three were stage I (15.78%),

12 were stage II (63.15%) and four were stage III (21.05%). After discharge: eight were stage II (42.1%), nine were stage III (47.36%) and two were stage IV (10.52%). In the group of patients operated on with 35 affected hips, 24 were stage II (68.57%) before the operation, 11 were stage III (31.42%). In this group, 21 hips progressed to stage II (60%), 13 hips to stage III (37.14%) and one hip to stage IV (2.85%) (**Figure 6**). The difference between the groups was statistically significant ($p = 0.00067$).

The Koo index was calculated in 11 patients, including five in the operated group and six in the non-operated group. For patients in the operated group, it was ≥30˚ in three patients in stages I and II < 30˚ in two patients in stage II. For non-operated patients, it was ≥30˚ in two stage II patients and <30˚ in four stage II and III patients.

3.4. Patient Satisfaction

In the group of non-operated patients, 11 patients were satisfied and two patients were not satisfied. In the operated group, 18 patients were very satisfied, two patients were satisfied and two patients were not satisfied. The statistical difference was not significant ($p = 0.075$).

Complications such as haematoma, infection or iatrogenic fracture were not reported in our patients.

4. Discussion

Most authors, such as Bellot *et al.* [18], Mont *et al.* [19] and Bozick *et al.* [20], consider that the effectiveness of drilling is modest, with a worsening of osteonecrosis in the 9 to 24 months following surgical drilling. The method of single drilling with a large diameter or multiple drilling with small diameter wires would explain their mixed results. In a comparative study by Woerner *et al.* [21], no significant difference was found between isolated surgical drilling and surgical drilling coupled with cancellous grafting. Their clinical results were comparable, as was patient satisfaction. This retrospective study of 22 patients (11 in each group) compared multiple fan drilling using a 2.5 mm Kirschner wire with 10 mm trephine drilling coupled with an autologous cancellous bone graft harvested from the proximal femur. According to Mukisi Mukaza *et al.* [22], simple

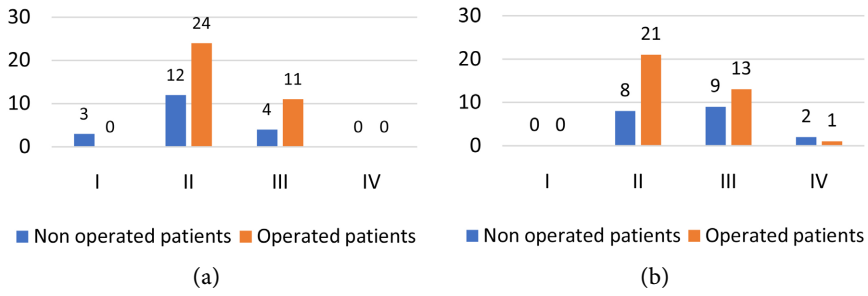


Figure 6. Distribution of patients according to ARCO stage. (a) Before treatment. (b) At last follow-up.

drilling is still appropriate for sickle cell ONTF. The decompression obtained with the 8 mm diameter auger considerably reduces stasis and hyperpressure in the femoral head. A significant reduction in intraosseous pressure in the femoral head after surgical drilling has been demonstrated by objective measurements using a bone puncture needle [23]. Intraosseous hyperpressure has been shown to play an ischaemic role in the pathophysiology of ONTF, as demonstrated by the work of Larsen [24] and Miles [25]. Our study described the value of in situ cancellous bone grafting coupled with surgical drilling. The surgical technique is easily reproducible and does not require a lot of surgical equipment. The 4 mm cylindrical autologous graft in the 8 mm cervical-cephalic tunnel of the bore maintains a better mechanical effect against femoral head collapse. It does not diminish the qualities of surgical drilling alone, does not have an obstructive effect, and is more resistant to bone graft necrosis over time. Some authors have reported the use of stem cell transplants in their surgical technique [26]. The technique is difficult to implement because it requires more equipment, and the therapeutic results remain mixed. The monocentric study setting enabled better follow-up of patients' progress. Brazzaville University Hospital is the largest specialist hospital in the country and provides specific treatment for ONTF.

Response to pain was poor in the non-operated group. Treatment with off-loading and analgesics was difficult to comply with because of the social stigma attached to extensive crutching, or impossible to comply with in the case of bilateral lesions. In the group of patients who underwent surgery, our study showed significant results ($p = 0.00004$). The decompression obtained by drilling may explain the immediate analgesic effect [22] and the arrest of deterioration in hip function [13] [16] [23]. When the surgical indications are respected, the MDP score has been improved in most series [18] [21] as in our study.

Bellot *et al.* [18] demonstrated the superiority of surgical drilling over surgical abstention in the stabilization of ONTF lesions. It allows a longer delay before hip arthroplasty [27]. In our series, the outcome was less morbid in the group of patients who underwent surgery ($p = 0.00067$). The patients who underwent surgery were at a less advanced stage at the longest follow-up. This stability of the lesion means that the time to arthroplasty can be extended. Our results suggest that surgery should be reserved for early stages I, II or III without fracture depression. This is consistent with series by several authors [28] [29] [30]. When the Koo index was calculated, it was better in the group of patients who underwent surgery. It is therefore important to diagnose the disease early in order to guarantee a better result. The bone graft used in our study could explain the better stability by preventing collapse of the femoral head, but also the absence of iatrogenic fractures caused by the embrittlement produced by the single-bore tunnel [18]. Cancellous bone grafting promotes long-term filling of the bone defect caused by surgical drilling [31].

Because our surgery was completely minimally invasive, it was easy to accept. It did not interfere with hip replacement surgery when necessary. It did not lead

to weakening of the local soft tissues of the hip, which are necessary for successful arthroplasty. There was no risk of infection because the surgical procedure was not invasive. Most of our patients were more satisfied after surgery.

The limitations of our study were the small study population of 35 patients, 22 of whom underwent surgery (55 hips, 35 of which underwent surgery), resulting in low representativeness. The single medical center limited the impact of the results. Only major complications were searched for in the follow-up.

5. Conclusion

Surgical drilling coupled with cancellous grafting is an effective therapeutic solution for the early stages of ONTF. Clinical results and symptom regression are better in patients who have undergone surgery than in those who have not. The surgical procedure is reproducible and does not require sophisticated equipment. It is easily performed in facilities that are even under-equipped, making it possible to manage ONTF, particularly in developing countries. Our study showed a considerable response in terms of pain relief and stabilization of necrosis. This also has the advantage of delaying hip osteoarthritis, which is disabling. The minimally invasive surgical technique led to greater patient acceptance and satisfaction. The indication for hip replacement surgery can be postponed for several years. This offers a reprieve and can help to prepare for the financial cost of prosthetic surgery, which is expensive in low-income countries. It also allows prosthetic surgery to be performed as late as possible, considering the limited half-life of the prosthetic implant.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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