Retrospective Study

RETROSPECTIVE CLINICAL AND RADIOGRAPHIC STUDY ON HETEROTOPIC OSSIFICATIONS AND HIP PROSTHESES FOR PRIMARY AND SECONDARY COXARTHROSIS: OUR EXPERIENCE

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ABSTRACT

Possible complications of hip prosthesis implants include the appearance of heterotopic ossifications (HO), i.e., the neoformation of bone tissue in the periprosthetic areas: it occurs in the months following the intervention due to a structural transformation of parts of the gluteal muscle. Materials and Methods: In the period between October 2014 and November 2023, at the same hospital facility by the same orthopedic team, 715 hip arthroplasty implantation surgeries were performed, of which 366 patients with coxarthrosis in the absence of recent fractures of the proximal epiphysis of the femur. Results The average age at the date of hip arthroplasty implantation surgery is 70.9 years. Radiographic checks performed after at least 3 months were taken into account to study the occurrence of heterotopic ossifications. In conclusion, in the event of the onset of HO, bloodless, physiotherapeutic, medical, and possibly radiant, timely, and close follow-up treatments are necessary to avoid the aggravation of local conditions.

KEYWORDS: *hip prosthesis implants, heterotopic ossifications, coxarthrosis*

INTRODUCTION

After the insertion of a hip prosthesis, the radiographic finding of small asymptomatic ossifications is common; it can rarely cause severe functional limitation up to complete blockage of the hip (1). The origin of this complication is almost unknown; individual constitutional factors are often called into question, although it is known that it occurs statistically more frequently in interventions following traumatic events.

Many authors have studied the possible prophylaxis of this complication, and the most effective practical suggestions have resulted:

- selection and care of the surgical technique;
- pharmacological prophylaxis (1);
- prophylaxis with radiation therapy (2);

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Heterotopic calcifications tend to reduce joint motility with varying severity depending on the location and extent of ossifications. In sporadic cases it may be necessary to remove such ossifications in order to improve joint movement.

Risk factors

The precise pathogenesis is still debated. Some risk factors are recognized, some are preventable, and others are not, and can be schematically divided into two categories: patient-related risks and risks related to the surgical technique (3-6).

Patient-related risk factors are:

- over 65 years of age;
- male sex;
- high BMI;
- previous brain or spinal trauma;
- presence in other ossification sites;
- systemic disorders such as spondylitis, hypertrophic osteoarthritis, diffuse idiopathic skeletal hyperostosis, Paget's disease, post-traumatic osteoarthrosis, osteonecrosis, rheumatoid arthritis;
- previous hip surgery.

Surgery related to risk factors are:

- invasiveness of the technique on muscle tissues;
- persistence of bone debris;
- hematoma;
- detachment of the gluteal muscles;
- cementation of the plant;
- release of the psoas tendon;
- trochanteric or femoral osteotomy;
- procedure duration exceeding 90 minutes;
- prolonged drainage beyond 24 hours.

Epidemiology

It is one of the most frequently encountered complications after first intervention prosthesis, reported variably from 5 to 87%, with an average incidence of 30%. However, clinically significant forms have a much lower incidence, from 0.5 to 12%, as determined by countless studies in the literature (7). The prostheses most prone to ossifications are those that require the use of cement to attach to the bone; today, they are used very little in young patients and are reserved for the elderly (8).

Pathophysiology

Chalmers et al. (9) have proposed 3 necessary conditions for the onset and formation of heterotopic calcifications:

- osteogenic precursor cells;
- inducing agents;
- triggering event.

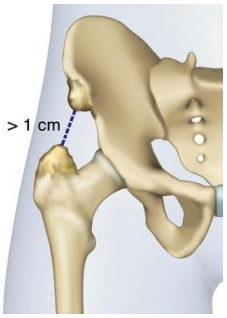
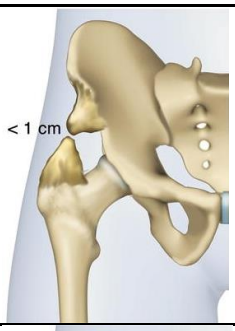
In fact, it has been seen that the main cause of heterotopic ossifications consists in an inappropriate differentiation of pluripotent mesenchymal cells into osteoblastic stem cells; however, the definitive trigger remains unclear, although Zaccalini highlighted that the demineralization of the bone matrix induces the formation of a morphogenetic protein (BMP) that could transfer from the traumatized bone to the surrounding tissues and thus stimulate the transformation of perivascular mesenchymal cells into osteoblasts (10). It has recently been proposed that prostaglandin E can also mediate the differentiation of progenitor cells.

A relevant figure is, finally, the observation of Tonna and e Cronckite (11), who noted the osteoblastic differentiation of primitive stem cells in the first 16 hours following an experimentally induced trauma on cat femurs with a peak of activity observed at 32 hours. However, although the causal factor remains unknown, there is no doubt that the formation of heterotopic calcifications depends on factors that, acting locally or systemically, influence the balance between osteogenesis and osteo-inhibition.

Classification

The Brooker Classification divides the extent of the formation of heterotopic calcifications after total arthroplasty into five grades: Grade 0, which is the absence of periprosthetic calcifications; Grade 1 is described as bone islands within soft tissues around the hip; Grade 2 includes bone spurs that originate from the pelvis or proximal end of the femur, leaving at least 1 cm between opposite bone surfaces; Grade 3 consists of bone spurs that originate from the pelvis or proximal end of the femur, reducing the space between opposite bone surfaces to less than 1 cm; Grade 4 shows apparent bone ankylosis of the hip (Table I) (12, 13).

Table I. *Brooker's radiographic Classification of the hip's heterotopic calcifications.*

Grade 0	Absence of calcification and ossification	
Grade 1	Bone islands in soft tissues around the hip	
Grade 2	Bone spurs starting from the pelvis and/or proximal end of the femur leaving the space of at least 1 cm between the opposite bone surfaces.	
Grade 3	Bone spurs starting from the pelvis or proximal extreme of the femur reduce the space between the opposite bone surfaces to less than 1 cm.	
Grade 4	Evident bone ankylosis of the hip	

Treatment

Asymptomatic patients have a quality of life comparable to patients without ossifications and do not need special attention. For patients with symptoms, especially those with severe movement deficit (degrees 3/4 sec. Brooker), ossification removal surgery is indicated (14).

Surgical indications for the excision of heterotopic ossification include:

- the improvement of the function;
- upright posture, sitting or walking;
- independence in dressing;
- the power supply;
- hygiene and repeated pressure sores from the underlying bone mass.

This surgery should usually be performed 12-18 months from the first to avoid the error of removing an ossification not yet fully formed, greatly increasing the risk of recurrence. For this reason, these patients are often asked to perform a bone scan. This examination gives us a general indication of the evolution of the pathology and its metabolic activity. The ideal candidate for surgical treatment before 18 months should not have joint pain or swelling, a normal level of alkaline phosphatase, and a 3-step bone scan indicating mature heterotopic ossification (15).

MATERIALS AND METHODS

In the period between October 2014 and November 2023, at the same hospital facility by the same orthopedic team, 715 hip arthroplasty implantation surgeries were performed, of which 366, in patients with coxarthrosis in the absence of recent fractures of the proximal epiphysis of the femur. The most widely used access route was the direct lateral route (Hardinge Bauer), carried out in 335 cases (92%) (Table II).

Table II. *Report of hip arthroplasty interventions on coxarthrosis and in the absence of recent fractures of the proximal epiphysis of the femur carried out in the period between October 1, 2014 and November 30, 2023 in our center.*

YEAR	N. HIP ARTHROPROSTHESIS IMPLANT SURGERY ON COXARTHROSIS	LATERAL ACCESS ROUTE (HARDINGE BAUER)	FRONT ACCESS ROUTE (SMITH - PETERSEN)	FRONT - LATERAL ACCESS ROUTE (WATSON - JONES)	POSTERO - LATERAL ACCESS ROUTE (GIBSON - MOORE)
2014	13	13	-	-	-
2015	41	41	-	-	-
2016	75	72	3	-	-
2017	70	55	15	-	-
2018	69	68	1	-	-
2019	28	28	-	-	-
2020	13	10	-	3	-
2021	17	15	-	1	1
2022	21	17	-	4	-
2023	19	16	1	2	-
TOTALE	366	335	20	10	1

The anterior access route to the hip (Smith - Petersen) was preferred in 20 interventions (5%). The anterior-lateral access route to the hip (Watson-Jones) was chosen in 10 interventions (3%). Only in 1 case has the posterior-lateral (Gibson-Moore) access route (Table III, Fig. 1).

Table III. *Stratification of the severity of heterotopic calcifications that appeared during the follow-up of hip arthroplasty implatation interventions on coxartrosis using the lateral access route.*

Brooker Classification	Number of cases	Number of cases (%)
,Grade 0	76	43.4%
Grade 1	48	27.4%
Grade 2	31	17.7%
Grade 3	13	7.4%
Grade 4	7	4%

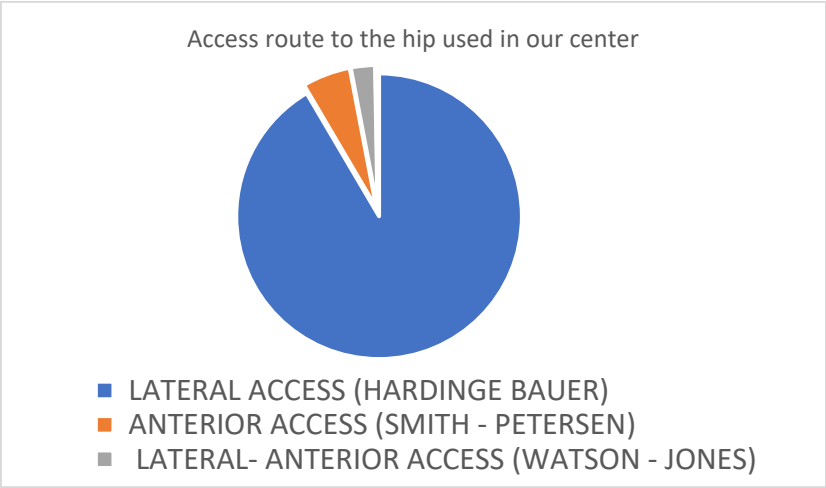


Fig. 1. *Access route to the chosen hip in hip arthroplasty implantation operations on coxarthrosis.*

The average age of hip arthroplasty implantation surgery is 70.9 years. Radiographic checks performed after at least 3 months were taken into account to study the occurrence of heterotopic ossifications. Patients who were unable to follow up for at least 3 months were therefore excluded from the study.

Initially the design provided for a follow-up of at least 6 months, but looking at the radiographic data shows an early appearance of the complication of ossifying myositis, which can become aggravating over time but, from our experience, there is no late onset (late-onset), in case of absence of early appearance of calcifications (first trimester post-intervention). This has therefore made it possible to enlist a greater number of patients.

The number of cases included in the study is therefore 196, of which 175 operated by preferring the direct lateral route, 14 the anterior route and 7 the anterolateral route. The heterotopic calcifications were classified according to the classification proposed by Brooker, which, as already mentioned, stratifies the severity of heterotopic ossifications into 4 classes.

According to this classification, the heterotopic calcifications that appeared at the periprosthetic site were then stratified within subgroups of patients operated with the direct lateral, anterior and anterolateral access routes.

RESULTS

Based on Brooker's classification:

- the heterotopic calcifications that appeared in cases of arthroprostheses implanted through direct lateral access were stratified into the following (Fig. 2):

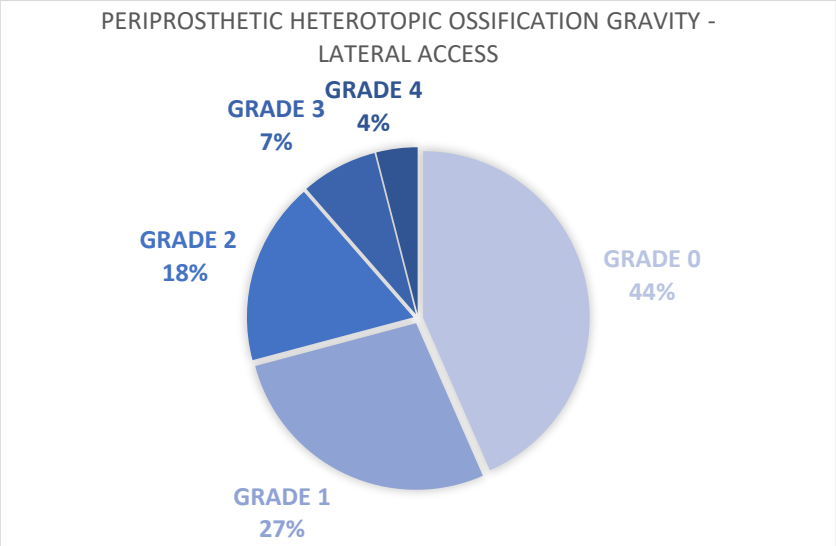


Fig. 2. *Stratification of the severity of heterotopic calcifications that appeared during the follow-up of hip arthroplasty implantation interventions on coxarthrosis using the lateral access route.*

- the heterotopic calcifications that occurred in the case of arthroproseses implanted through the anterior access were stratified into the following (Table V, Fig. 3):

Table V. *Stratification of the severity of heterotopic calcifications that appeared during the follow-up of hip arthroplasty implantation interventions on coxarthrosis using the anterior access route.*

Brooker Classification	Number of cases	Number of cases (%)
Grade 0	10	71.4%
Grade 1	2	14.3%
Grade 2	1	7.1%
Grade 3	1	7.1%
Grade 4	-	0%

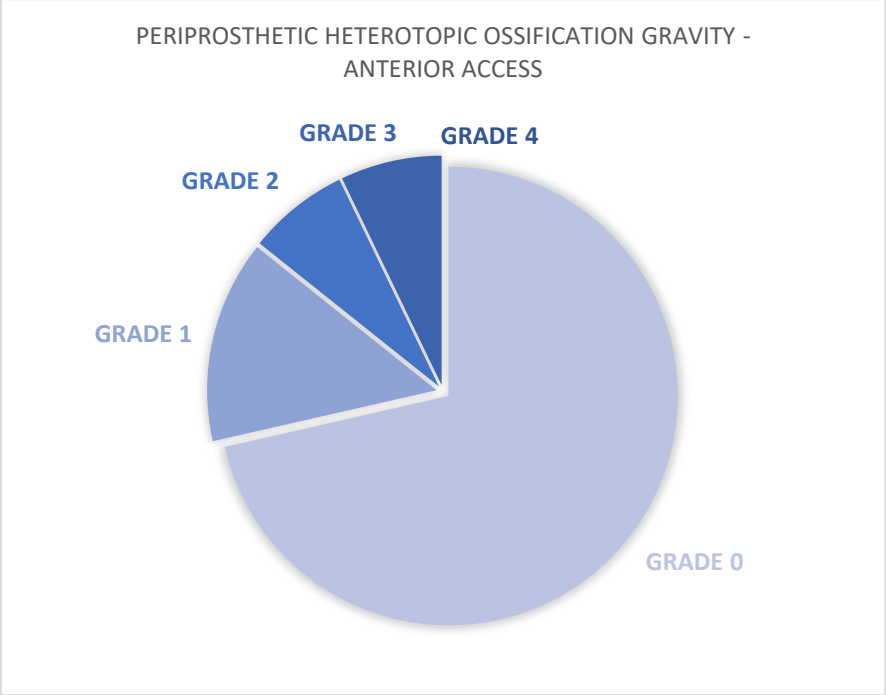


Fig. 3. *Stratification of the severity of heterotopic calcifications that appeared during the follow-up of hip arthroplasty implantation interventions on coxarthrosis using the anterior access route.*

- the heterotopic calcifications that appeared in the case of arthroprostheses implanted through the anterolateral access were stratified into the following (Table VI, Fig. 4):

Table VI. *Stratification of the severity of heterotopic calcifications that appeared during the follow-up of hip arthroplasty implantation interventions on coxarthrosis using the anterolateral access route.*

Brooker Classification	Number of cases	Number of cases (%)
Grade 0	5	71.4%
Grade 1	1	14.3%
Grade 2	1	14.3%
Grade 3	-	0%
Grade 4	-	0%

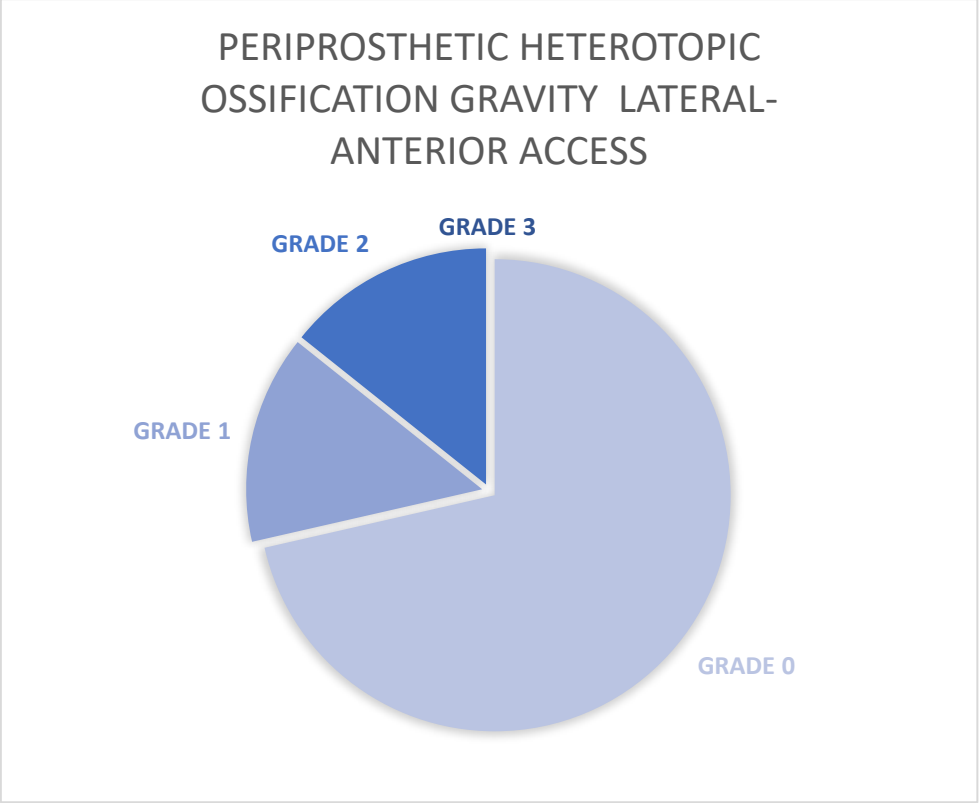


Fig. 4. *Stratification of the severity of heterotopic calcifications that appeared during the follow-up of hip arthroplasty implantation interventions on coxarthrosis using the anterolateral access route*

Considering the significant disproportion in absolute numbers regarding the use in our experience of the lateral access route compared to the others, the data that emerged were then reworked in percentage terms, demonstrating that the lateral access route direct to the hip does not increase the risk of developing symptomatic and severe periprosthetic heterotopic calcifications (Fig. 5).

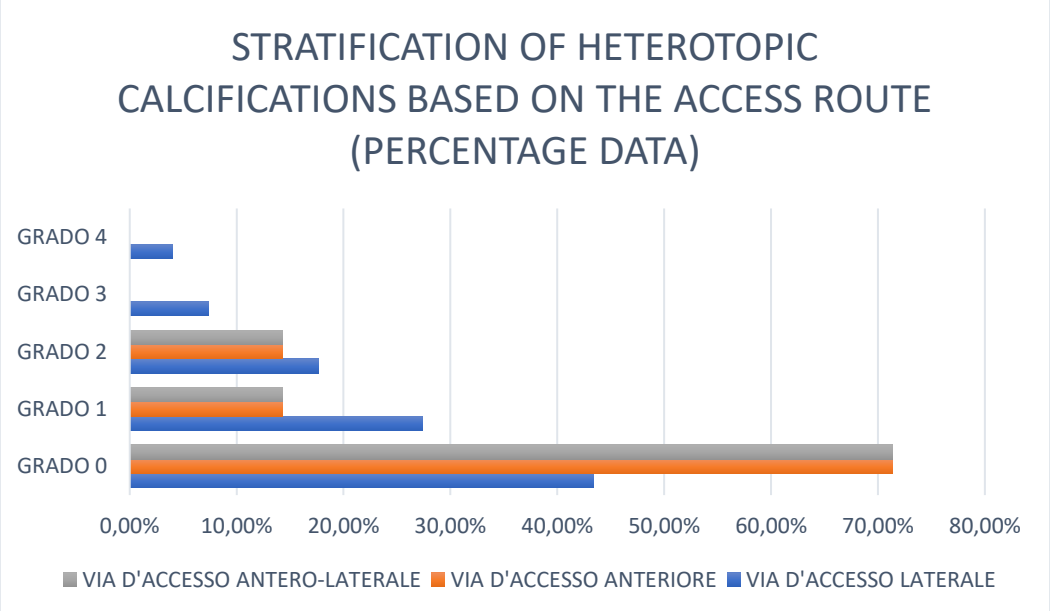


Fig. 5. *Stratification of heterotopic calcifications by access route (percentage data).*

In fact, these data show that, although the lateral access route direct to the hip is preferred in absolute terms, when the data are reported as a percentage, the three access routes studied do not show substantial differences in the appearance

of severe ossifying myositis. Using the reworked data in percentage terms, there is therefore no statistically detectable superiority in the choice of the access route to reduce the severity of the periprosthetic heterotopic calcifications that have appeared.

DISCUSSION

The data that emerged from this retrospective study, not free of bias and performed on a limited sample in accordance with what is reported in the literature for the postero-lateral route (16, 17), show that the choice of the lateral access route directed to the hip, preferred in our center, does not expose patients to a greater risk of developing severe and therefore symptomatic heterotopic ossifications. From the literature review, the same conclusion was reached for the comparison between the AMIS (Anterior Mini Invasive Surgery) approach and the direct lateral route: AMIS has been associated with better clinical and functional outcomes, but with regard to HO, the superiority of the AMIS approach in terms of incidence has not been demonstrated (18).

Contrary to what one might therefore think, it is not the extension of the access route itself that determines a risk factor for the onset of ossifications, nor, in our opinion, is the unique search for an intermuscular-only approach. Still, it is the muscular trauma, the tearing of tissues, the bleeding and the subsequent formation of periarticular haematomas, and the use of intraarticular drainage, especially in predisposing contexts (19).

The review by Cohn and colleagues on the appearance of HO after the implantation of PTA (20) reports the great variability of theses (sometimes in opposition to each other) relating to how the development of HO can be influenced by the surgical approach used in PTA. In a study of 507 consecutive patients with osteoarthritis or avascular necrosis, Morrey et al. (21) found that the incidence of severe HO was lower with a posterior approach (22%) than with an anterolateral (29%) or transtrocanteric approach (28%).

In a study of 1420 consecutive PTAs using the direct lateral approach, an overall incidence of HO of 27% was found, with HO occurring around the large trochanter in 15% of the hips. These results were confirmed by Eggli and Woo (5), who found that the incidence of HO was greater than 8.1% with an anterior or anterolateral approach compared to a posterior approach and that the incidence was greater than 15.1% when a trochanteric osteotomy was performed. Retrospectively, various lateral approaches were compared and found to have a 5x greater risk of HO with the Liverpool method than the Hardinge or transtrocanteric approach. Other authors (22) found no effect of the surgical approach on HO.

CLINICAL CASES

There are two clinical cases in which the appearance of periprosthetic heterotopic calcifications was rapid and severe (grades 4 and 3, respectively). In the first case, it was necessary to intervene surgically about 14 months after the implant by performing an arthrolysis (exal of the femoral-acetabular bone bridge and joint mobilization); in the second case, however, an adequate and regular physiotherapy treatment, at the same time as the pharmacological treatment, led to good results (see clinical images at six months) (Fig. 6-11).

Clinical case A

76 years old - male - PTA system sx - Direct lateral access route performed.

Fig. 6. *Preoperative Rx: III-degree sec. Kellgren-Lowrance classification.*

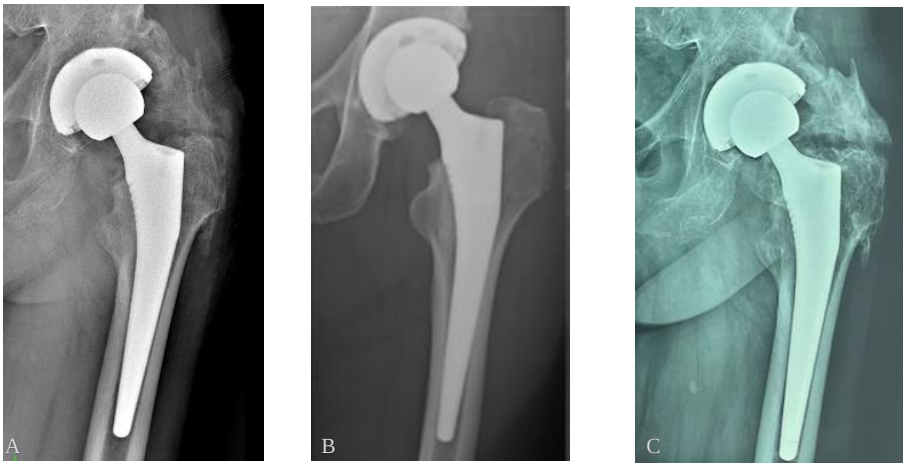


Fig. 7. *Postoperative X-ray checks at 0, 3 and 12 months. **A**): Post operative; **B**): At 3 months **C**): At 12 months.*

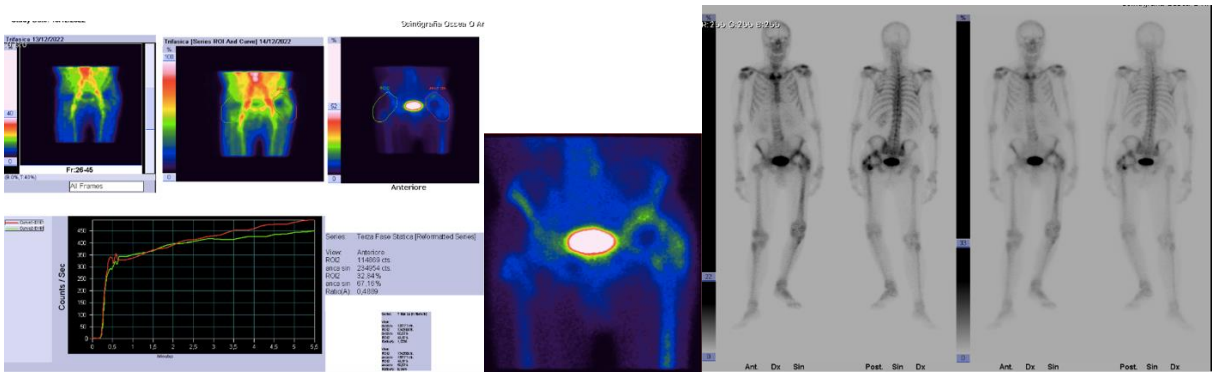


Fig. 8. *Scintigraphy performed at 4 months documenting significant hyperfixation in the late phase only as by osteoblastic type reaction.*

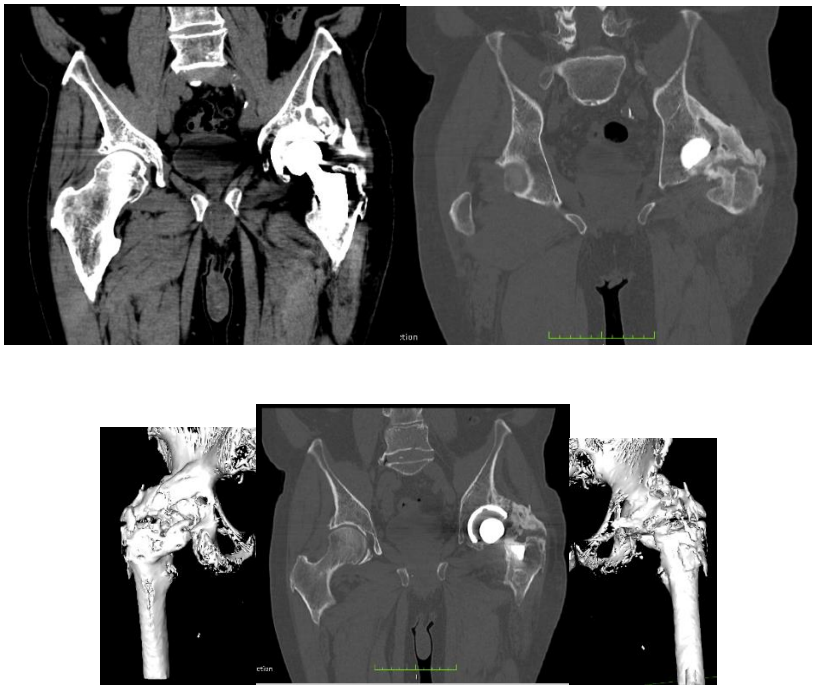


Fig. 9. *CT performed at 12 months post-implantation of PTA.*

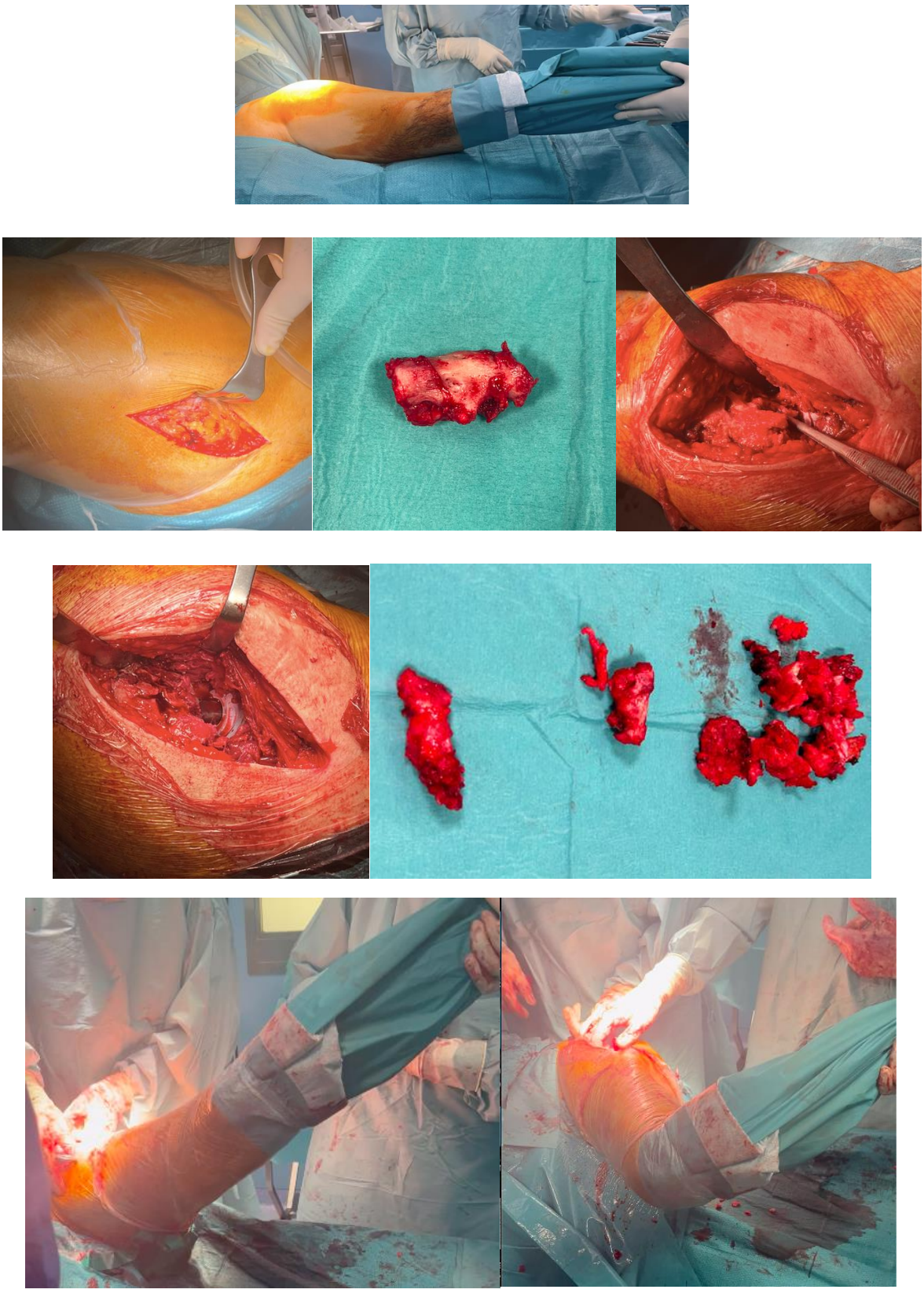


Fig. 10. *Intraoperative photographic sequence of arthrolysis surgery (bone bridge removal and joint mobilization), performed 14 months after PTA implantation.*

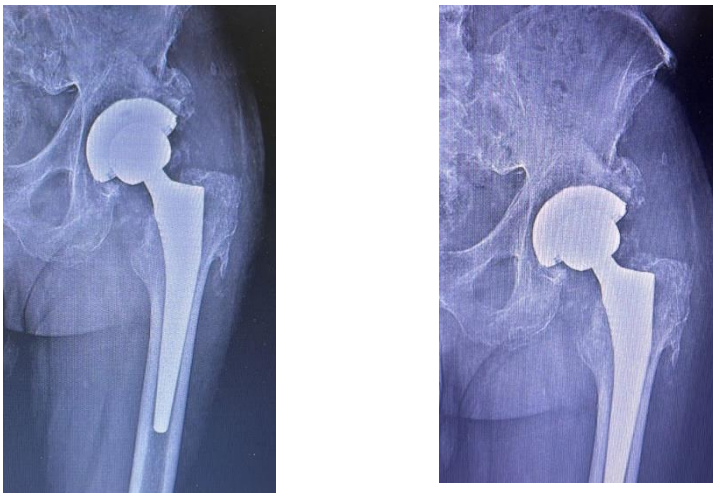


Fig. 11. *Radiographic control post-intervention of arthrolysis and clinical control at 1-month postarthrolysis.*

Clinical case B

65 years old - female - PTA system sx - Direct lateral access route.

Fig.12. *Preoperative: II-degree sec. the Kellgren-Lowrance classification, with severe limitation of pace and daily activities, more intense pain on the right.*

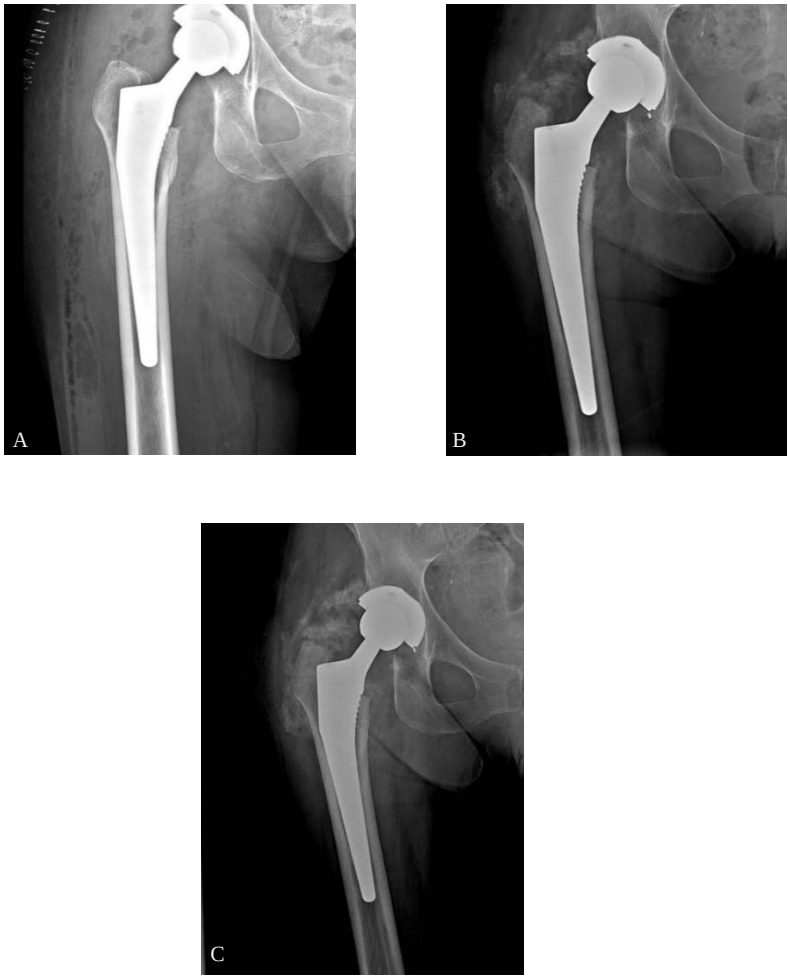


Fig. 13. *Postoperative X-ray checks at 0, 1, and 3 months. **A**): postoperative; **B**): at 1 month **C**): at 3 months.*

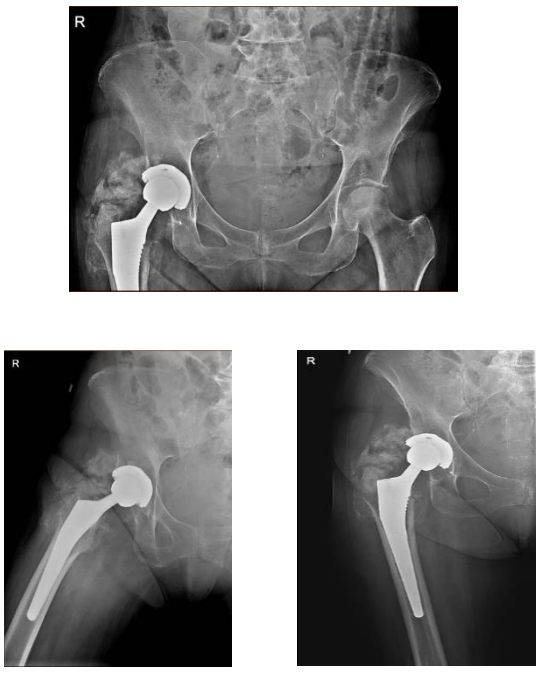


Fig. 14. *Radiographic and clinical control after 6 months (grade 3 Broker): Increase of ROM after a correct and regular cycle of FKT.*

CONCLUSIONS

Although heterotopic calcifications are a rarely disabling complication, they must be prevented with all the strategies known to date, especially because the weapons of prevention are clear and simple (23). Nevertheless, even with proper prevention, it is impossible to avoid it in all cases to substantially reduce its incidence, accurately evaluate patients with pre- and postoperative clinical and radiological controls, administer the right medical prophylaxis, and minimize surgical stress without the peremptory need to change the surgical approach radically, but managing the tissues in a less traumatic way possible, respecting muscles and tendons and limiting bleeding as much as possible with adequate intraoperative hemostasis are the best procedures.

Obviously, in the event of the onset of HO, a bloodless, physiotherapeutic, medical, and possibly radiant, timely, and close follow-up treatment is necessary to avoid the aggravation of local conditions. In cases where it was not possible to stem the appearance of calcifications with severe limitation of the ROM (grade 3-4 sec. Brooker), it will then be appropriate to evaluate a surgical treatment preceded by appropriate second and third level investigations and to be scheduled with appropriate timing.

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