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CASE REPORT
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Early Onset Rapidly Progressive Osteoarthritis of the Hip in a Young Athlete

Časně nastupující rychle progredující osteoartróza kyčle u mladé atletky

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SUMMARY

We report and discuss a very rare case of early-stage rapidly progressive osteoarthritis (RPO) in a 33-year-old female athlete. The etiopathology of RPO remained unclear, although in this case mechanical overloading due to constant joint overuse appeared to be the only significant contributing factor to the very early development of RPO.

Key words: rapidly progressive osteoarthritis, rapid destructive arthrosis, hip arthrosis, total hip arthroplasty, athlete, osteoarthritis.

INTRODUCTION

Rapidly progressive osteoarthritis (RPO) is a rare entity with unknown pathogenesis. First described by Forestier in 1957 and coined as "rapidly destructive hip osteoarthritis" by Lequesne (9) and Postel (18) in the 1970s. It is characterized by a rapidly progressive destruction (within a few months) of both the femoral and acetabular aspects of the hip joint, up to complete disappearance of the femoral head (11, 12 and references therein). Given its rarity, case reports or small series are still limited. Hu et al. recently reviewed the literature and, overall, 23 publications with 17 detailed cases of RPO met the inclusion criteria (5). The only prevalent factors associated with RPO were: (I) age > than 60 years (i.e., mean 69.2 years; range 37–81 years); (II) female gender; and (III) presence of underlying systemic diseases, e.g., rheumatoid arthritis, diabetes mellitus, or systemic lupus erythematosus (5). The most commonly accepted diagnostic criteria of RPO were joint space loss occurring at a rate > 2 mm per year, or a loss of > 50% of joint space in 1 year (1). RPO was often misdiagnosed as other diseases, including rheumatoid arthritis, neuroarthropathy, septic arthritis, osteonecrosis of the femoral head, seronegative arthritis, and osteoarthritis (OA), (5). Although the rapid clinical course and extent of bone destruction clearly differ from the pattern observed in degenerative processes, many authors believe that RPO is a form or subset of degenerative OA (16, 20, 25). They also suggest an interaction of mechanical stress, cartilage degeneration, and bone response in the pathogenesis of RPO ((12) and references therein).

Medical history

The young female athlete (33 years; height 176 cm; body weight 57 kg; BMI 18.4) had an unremarkable medical history, except for typical childhood diseases and a lactose intolerance. The family history was negative for inherited diseases, especially hip abnormalities. Her younger brother was treated as a neonate with spreader pants for 4 weeks only. She did not undergo routine hip sonography as a baby.

She did not consume animal milk products and used oat milk instead. She added calcium, vitamin D3, and occasionally magnesium in case of muscle spasms when performing sports, ate meat only occasionally, preferred fish, avoided fat and sugar, and drank 3 liters of water daily. She did not smoke, did not consume alcohol on a regular basis, and showed no history of drug or medication intake, while taking a combined oral contraceptive (Maxim®; Jenapharm, Jena, Germany).

Since the age of 24, she underwent a routine complete blood count screening (https://medlineplus.gov/bloodcounttests.html) every third year at her family physician's office, which never revealed any abnormalities.

She is married without kids and lives in a house with 17 steps. After high school, she studied business administration and then worked as a business consultant for 5 years. Thereafter, she worked as the head of a department in a telephone company.

At the age of 8, she started horse riding on the leash 3 times a week for 2 years, then she continued without the leash until age 15 (Table 1). Thereafter, she went horse riding 5 times a week until she turned 18 and then continued to ride every day for approximately 2 hours. She also

Table 1. Summary of repetitive load and impact events (in particular on the left hip joint)

Age (years)	Sports activity		Remarks
8 to 10 10 to 15 15 to 18 from age 18	Horse riding on the leash Horse riding without a leash Horse riding Horse riding	(3x/week) (3x/week) (5x/week) (daily; 2 hours/day)	Mounting always with left foot in the stirrup; participation in competitions
9 to 15 16 to 18	Athletics Athletics	(4x/week) (2x/week)	Favorite disciplines: sprint, hurdles, long jump, and high jump; Left supporting leg
from age 19	Jogging	(3x/week; 10 km each)	–
24 to 30	Snowboarding	(30x/winter season)	Left leading leg

participated in horse riding competitions. She always mounted the horse from the **left** side with her **left** foot in the stirrup. At the age of 14, she fell off the horse and broke her left scaphoid bone, which was surgically pinned.

In addition, she performed athletics 4 times a week since the age of 9 with her favorite disciplines sprint, hurdles, long jump, and high jump (Table 1). The **left** leg was her supporting leg. At the age of 16, she reduced athletics to twice a week and stopped at the age of 18. Subsequently, she started jogging a distance of approximately 10 km for 3 times a week. After turning 24, she started snowboarding about 30 times per winter season until she turned 30, with her **left** leg being the leading one. She never experienced any major trauma, and after minor trauma, including falls, she claimed to have never felt pain for more than a few minutes except for the above-mentioned scaphoid fracture.

In November 2016, she suddenly experienced very intense pain (10 on the visual analogue scale) in the area of the left hip while stretching her body upon trying to reach something on the top shelf. She described the condition as a 'blockade', being so severe that she could no longer move her left leg (Table 2). An orthopedic physician gave her an injection in the lower spine area without any improvement. On the next day, after massage physiotherapy (PT) and stretching exercises, the pain slowly disappeared. Since that time, she experienced pain during extreme hip movements with some pain-free days. Starting in 2017, she suffered from 2 episodes of approx. 1 week each. X-rays of the entire pelvis and the left hip taken in January 2017 revealed a normal hip joint (i.e., without clear OA signs such as narrowing of the joint space, subchondral cysts or osteophytes and only borderline sclerosis of the left acetabular roof), however with an overall reduced acetabular roof, more pronounced on the **left** than on the right side ((Fig. 1; Table 2). The concurrent magnetic resonance imaging (MRI) of the left hip was unremarkable, with no clear lesion of the labrum (not shown).

Since the beginning of 2018, she also reported morning start-up pain and even more pain in the evenings while continuing with sports (Table 2). At this time, she received one steroid injection into the left hip joint and remained pain-free for around 2 months. Subsequently, morning and evening pain returned and, in addition, she experienced stress pain and pain after sitting down for 2 hours. A treatment course of 5 hyaluronic acid (HA) injections into the left hip joint then led to a pain-free in-

Fig. 1. X-rays of entire pelvis (left panel) and left hip (right panel) in January 2017; normal hip joint, with a reduced acetabular roof, more pronounced on the left than on the right side.

Table 2. Summary of diagnostic or clinical findings and therapy

	X-ray	MRI	Arthro-MRI	Symptoms/sports	Therapy
11/2016 01/2017	unremarkable	unremarkable		Severe blockade; few days pain (2x); sports unchanged	PT (1x; massage, stretching)
01/2018 12/2018				Start-up pain, evening pain; sports continued under therapy	Steroid inj.; HA inj. (5x) HA inj. (5x)
02/2019 04/2019 09/2019	OA Toennis grade 1		Undislocated tear ant./ sup. labrum, edema + fiber ruptures in m. iliopsoas, probably due to muscle pulling, otherwise unremarkable, no bone marrow edema (BME)	Activity-dependent pain until 06/2019; slightly reduced deep internal rotation and flexion, otherwise free range of motion; sports continued, intensity reduced according to pain	Diclofenac; HA inj. (5x) HA inj. (5x)
01/2020 08/2020 11/2020	OA Toennis grade 3			Pain after lifting; Pain exacerbation, extension/flexion 0-0-95°, internal/external rotation 10-0-50°, pronounced rotational pain.	HA inj. (3x; high conc.) THA

Fig. 2. X-rays of entire pelvis (left panel) and left hip (right panel) in January 2019; maximally an OA Toennis Grade 1 in the left hip (minimal joint space narrowing, acetabular roof sclerosis, beginning lateral osteophyte formation; no subchondral cysts or femoral head deformity).

terval for almost the entire year of 2018. At the end of 2018, she received a second course of 5 HA injections, but this time the pain-free interval lasted only 2 months. During 2018 she added a nutritional supplement (orthomol arthroplus; Orthomol pharmazeutische Vertriebs GmbH, Langenfeld, Germany) containing glucosamine and chondroitin to her diet for a total time of 3 months. Since December 2018 she added the two substances from a different company. She felt that none of those substances influenced her symptoms. At the beginning of 2019, she started taking medication for the hip pain (Diclofenac 25 mg, 1–2 tablets if necessary, about once a week). In 02/2019, X-rays still showed max. an OA Toennis Grade 1 in the **left** hip (minimal joint space narrowing, acetabular roof sclerosis, beginning lateral osteophyte formation; no subchondral cysts or femoral head deformity (Fig. 2, Table 2), however with clear progress from 01/2017 to 02/2019 in this young patient. At this time, the result of an arthro-MRI (Fig. 3) of the left hip was described by the radiologist as:

1. Slightly reduced waist of ventral femoral head/femoral neck transition; Ø herniation pits.
2. Undislocated tear of the anterior and also to a limited degree of the superior labrum.

Fig. 3. T2-weighted Arthro-MRI of the left hip in January 2019; slightly reduced waist of the femoral head/femoral neck transition ventrally without herniation pits, undislocated tear of the anterior and also to a limited degree of the superior labrum, edema and fiber ruptures in the m. iliopsoas, probably as a sign of muscle pulling, no evidence of cartilage delamination or bone marrow edema (BME); a white arrow indicates the undislocated tear of the anterior labrum.

3. Edema and fiber ruptures in the m. iliopsoas, probably as a sign of muscle pulling.
4. No evidence of cartilage delamination.
5. No sign of bone marrow edema (BME).

Table 3. Toennis grading of OA

Grade 0	no signs of osteoarthritis
Grade 1	sclerosis of the joint with minimal joint space narrowing and osteophyte formation
Grade 2	small cysts in femoral head or acetabulum, moderate joint space narrowing
Grade 3	advanced arthritis, large cysts in femoral head or acetabulum, joint space obliteration, severe deformity of femoral head

Thereafter, the therapy with HA injections was continued once every 4 weeks (until 06/19). A physical examination in April 2019 revealed an almost unremarkable gait, excellent range of motion up to hypermobility of the right hip, with excellent mobility of the left hip with a slightly reduced deep internal rotation and flexion (the latter usually being painful, but not during the examination). A psoas snap could not be triggered.

During the summer of 2019, she experienced pain relief, leading to a treatment pause. In autumn pain exacerbated, followed by another course of 5 HA injections until December. Then she helped someone moving his home, with pain worsening afterwards. At the beginning of 2020, 3 injections of highly concentrated HA were applied, leading to a pain-free interval of 4 weeks, followed by pain exacerbation in August 2020. From 01/2018 to 04/2020, she received a total of 23 intra-articular (i.a.) HA injections, which always led to pain relief of different time spans without a history of pain, fever or chills after the injection, arguing against any history of joint infection (Table 2). During intervals of pain she received PT. X-rays taken in 08/20 revealed an OA Toennis Grade 3 (Fig. 4, Table 3).

Concurrent physical examination showed an upright pelvic position, no gluteal insufficiency, lumbar spine,

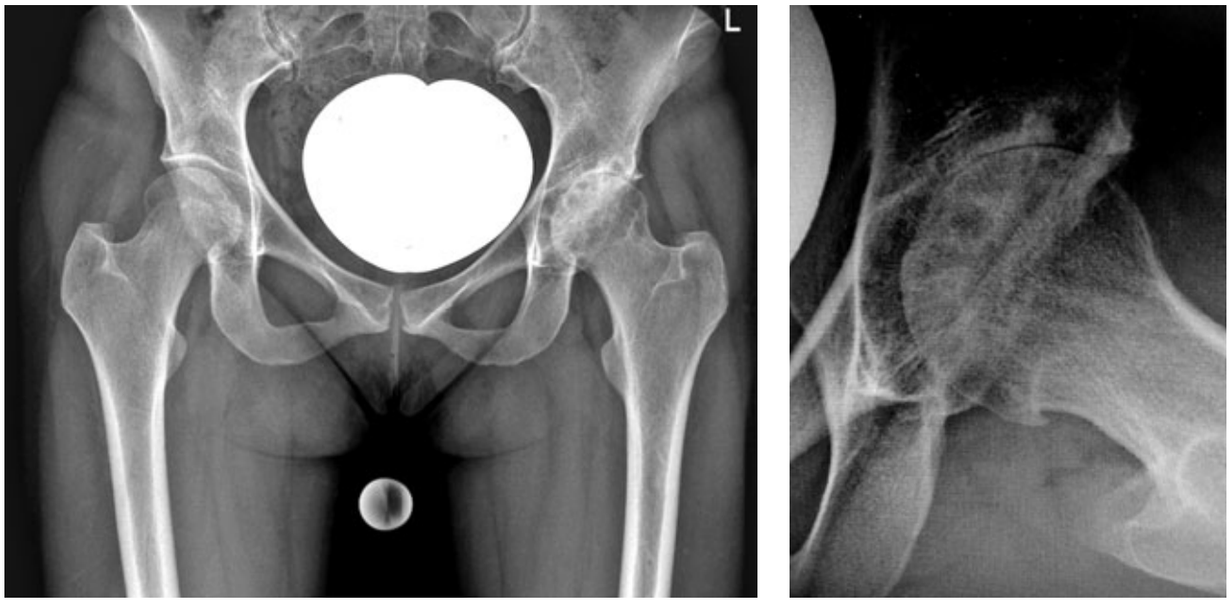

Fig. 4. X-rays of entire pelvis (left panel) and left hip (right panel) in August 2020; OA Toennis Grade 3.

and ileosacral joint unremarkable, Lasègue negative on both sides, peripheral sensory motor skills and blood circulation intact, right hip: extension/flexion 0-0-120°, internal/external rotation 70-0-60° without rotational or compression pain; left hip: extension/flexion 0-0-95°, internal/external rotation 10-0-50°, pronounced rotational pain.

In November 2020 total hip arthroplasty (THA) with an uncemented, short stem hip prosthesis was performed via a minimally invasive approach. The patient recovered quickly without complications and was planning to get back to her sports activities as soon as possible.

DISCUSSION

We report a new case of RPO in a young athlete, characterized by clear deformation of femoral head and joint space obliteration within only 18 months. None of the known diseases predisposing to RPO was observed in this case. Gorham-Stout disease (GSD), a rare bone disorder with lymphangiomatosis and massive osteolysis (https://rarediseases.org/rare-diseases/gorham-stout-disease/), was also considered, but considered very unlikely due to the absence of the classic 4 radiological stages of massive, rapidly progressing osteolysis (11, 13, 19, 22, 23) and the lack of contrast enhancement in the Arthro-MRI (1, 2, 3).

Potential underlying mechanisms

Mechanical overloading

The case presented with numerous repetitive load and impact events, especially on the **left** hip joint, starting from the age of 8 (Table 1; see preferential use of **left** leg as mounting, supporting, and leading leg). Considering this very conspicuous history, and excluding other known causes of RPO, sports-related excessive mechanical overloading may be the most probable cause for this early onset RPO. This is in analogy to reports showing that structural alterations causing locally high biomechanical strains exceeding the material properties of the tissue may be predictive of rapid progression in late onset OA (24).

Minor cartilage wear and bone sclerosis was already present in 02/2019, however in particular BME was not yet visible. This complicates the case, since there are currently no known biomarkers or risk factors of RPO development in young patients, except for female gender and the presence of certain systemic diseases not observed here (5). In particular, it is unclear how the present patient differs from other "high-load" young women without development of RPO (e.g., gene polymorphisms/expression or osteoclast function (6, 16)). In this context, lactose intolerance with potential consequences on the calcium equilibrium has not been reported in connection with RPO, although frequent milk consumption may contribute to delayed progression of female OA (10)

Structural alterations

In the current case of RPO, no knee malalignment, meniscal dysfunction, or femoro-acetabular impingement was observed. Also, except for a non-dislocated tear of the anterior and to some degree of the superior labrum, and a partially reduced acetabular roof, no further injury of the hip osteochondral unit was present (see below). Thus, structural alterations do **not** appear to be the basis of the present RPO, in agreement with a high prevalence of cartilage defects in patients without any structural bone abnormalities in arthro-MRI (15). Rather, microtraumata of the articulating cartilage or the underlying subchondral bone below the detection limit of the common imaging techniques could be discussed as a reason for the RPO (1, 7).

However, there may still be some remaining doubt, whether the non-dislocated labral tear did not influence the progression of RPO in the present case. Indeed, Neumann et al. (15) determined the prevalence of labral tears and cartilage lesions in patients with mechanical symptoms of the hip using arthro-MRI. Remarkably, cartilage loss was observed in the same region as the labral tear, with the grade of cartilage loss correlating with the degree of labral tear. However, a high grade of OA cartilage loss was usually correlated with a high grade of BME, whereas the present case showed no BME at any stage of the history. Thus, a contribution of the minor, non-dislocated labral tear to the present RPO case is very unlikely.

Trauma

The patient denied any major trauma, and never felt joint pain for more than a few minutes with the exception of a scaphoid fracture at the age of 14. Accordingly, no BME was documented in the subchondral bone of the hip joint in the two MRIs performed 2 years apart from each other in 2017 and 2019. Thus, in agreement with previous literature reviews (4), a manifest trauma as an underlying reason for the present RPO is also unlikely.

Microvascular alterations

Especially for the rapid progression of cartilage and bone destruction between 02/2019 and 08/2020, an insufficient nutrition of the subchondral bone due to an altered microvascular system may have played a major role, in analogy to the reasons discussed for the occurrence and progression of avascular femur necrosis (8, 14). Indeed, some authors suggested altered blood supply as an important factor for bone lysis and destruction (25) and recent studies have reported subchondral insufficiency fractures in RPO (5, 17). Also, individual authors hypothesized that osteoporosis may be related to the pathogenesis of RPO, whereas other authors showed that RPO of the hip is not accompanied by generalized osteoporosis ((17) and references therein). Finally, some studies reported elevated levels of prostaglandins, interleukin-1, and proteolytic enzymes in the synovial fluid in association with hip RPO, but not with primary coxarthrosis ((5) and references therein). However, the present case showed no signs of: i) altered vascularity (e.g., necrosis, cysts, or BME); ii) bone lysis or subchondral insufficiency fractures (neither in the MRI at symptom onset, nor in the arthro-MRI ap-

prox. 2 years later); or iii) localized/transient osteoporosis in this young, very active athlete, who supplemented calcium and vitamin D. Finally, the synovial fluid was unfortunately not analyzed and no histologic or molecular biology studies were performed after removal of the femoral head, since the joint grossly looked like common OA to the surgeon. Thus, the above reasons can be either excluded or at least not validated in the present case of RPO.

Steroid or HA injections

The patient received a single i.a. steroid injection. Hess et al. (4) recently assessed a potential relationship between hip RPO and i.a. steroid injections, without clear indications for either a causal or a coincidental relationship. Tiwari et al. (21) suspected an association in a rare case of hip RPO in a 62-year-old woman, who developed RPO within 2 months of an i.a. steroid injection. Although the long time between the steroid injection and the rapid progression of the current RPO between 02/19 and 08/20 makes causality less likely, an acceleration of the hip degeneration cannot be totally excluded. Also, effects of the numerous i.a. HA injections, albeit lege artis and performed with written patient consent, cannot be ruled out, although there are currently no studies suggesting or suspecting a link of repeated i.a. HA injections and RPO.

Preventive lifestyle changes or diagnostic/therapeutic procedures

The key question remains, whether the rapid progression of cartilage and bone destruction from 02/2019 to 08/2020 could have been prevented by lifestyle changes or diagnostic/therapeutic procedures. Frequent periods of morning start-up pain and aggravated evening pain led to the physician's recommendation of a substantial reduction of sports activities and/or a change to lower impact sports. However, due to her passion for the physical movement and its importance for her well-being, the patient continued sports activities on a level adjusted to the pain intensity. Since this is the first-time report of a fulminant development of RPO in a very young athlete (age 33), this possibility should be considered in future cases and possibly lead to a transient complete interruption of all physical activities until completion of diagnostic work-up, followed by a gradual restart upon amelioration of the clinical signs. If the pain should return upon reloading the hip joint, a long-term complete exclusion of high-impact sports may be advisible, with some low-impact sports as a possible adjunct. In view of a possible tendency of young patients to underestimate the potential long-term damage of mechanical overloading by constant joint overuse, this may have to be emphasized more strictly and stringently. Future studies in this orphan RPO in very young patients will be difficult due to the low frequency, but may provide more clues to the prognosis and/or prevention of cartilage and bone destruction.

The last question is, whether shorter intervals of diagnostics or an improved score system could have prevented the development of RPO in the present case. In general, the extremely rapid progression of cartilage and bone destruction (ranging from 6 weeks to 2 years: (4)) makes it very difficult to choose generalized and appropriate diagnostic intervals, in particular in the present well-nourished, generally healthy young patient. However, within the economic limitations frequent MRI controls upon reduced joint loading and subsequent graded joint reloading may be a tool to judge the risk of joint destruction in suspected cases of RPO.

Even a novel RPO grading system combining clinical and radiological characteristics (26) may not have prevented the present RPO, since the radiological signs in 02/2019 were only minor.

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