The fate of ARCO stage-II femur head necrosis with ring-shaped hardening zone: forty-one hips followed for average of nine years

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Abstract

Purpose

The goal of this retrospective study is to report the lower collapse risk and good prognosis of the ARCO stage-II femur head necrosis with ring-shaped hardening zone.

Methods

We retrospectively recruited 30 patients (41 hips) with ring-shaped hardening zone from the ARCO stage II femur head necrosis. In these 41 hips with ring-shaped hardened bands, we found two subtypes which named type A and type B by us respectively. These hips were followed for a minimum of 5 years after the diagnosis. (average 9 years).

Results

20 (48.8%) of the 41 hips suffered from hip pain, 18 (43.9%) of the them were painlessness, and 3 (7.3%) of the them were discomfort. Without special treatment, 9 (22.0%) of the 41 hips collapsed, 8 of them were type B and one was type A. At the last follow-up, the collapse of the nine hips were without apparent progress. At the most recent follow-up, the thirty patients had good daily hip function, 39 (95.1%) of the 41 hips were asymptomatic and only 2 (4.9%) of them were discomfort.

Conclusions

This study demonstrates that the ARCO stage II femur head necrosis with ring-shaped hardening zone at the middle of femoral head (stay away from the weight-bearing area) which called type A by our team have a low frequency of collapse. Surprisingly, we found that regardless of type A or type B, whether or not collapse occurred, the stage-II femur head necrosis with ring-shaped hardening zone has a good prognosis without special treatment.

Introduction

Non-traumatic osteonecrosis of the femoral head (ONFH) commonly occurs in young and middle-aged adults and the prevalence has been reported to be increasing. [1, 2] Non-traumatic ONFH is a potentially devastating disease that often leads to collapse of the femoral head and osteoarthritis of the hip. [3, 4, 5] One of the main factors affecting the prognosis of femur head necrosis is femoral head collapsing. Current researches indicate that most of the cases collapse within 1–3 years after diagnosis, but, clearly, not all of them. The past research had showed the size and location of the lesion are the most important risk factors for symptom development. The necrotic type with small size and middle location has a better prognosis [6, 7, 8] Other researches described the case with recognizable necrotic foci within the femoral heads and a normal contour of the weight-bearing surface present no symptoms and normal hip function. [10, 11, 12] Furthermore, a research pointed that a type which necrotic foci presented a round, cystic appearance circumscribed by radiodense lines on AP roentgenograms may need no treatment or

less aggressive treatment than other types. [13] Currently, many studies have tried to predict the collapsing of a necrotic femoral head, however, due to the complexity of femur head necrosis, no researches have clearly indicated which type has a lower risk of collapse and a better prognosis. The goal of this retrospective study is to report the good prognosis of the ARCO stage-II femur head necrosis with ring-shaped hardening zone. At the same time, we try to introduce the lower collapse risk type of femur head necrosis that we found.

Patients And Methods

Patients

Association Research Circulation Osseous (ARCO) stages [14] were used for classification of osteonecrosis (Table 1, 2). From 1996 to 2019, we retrospectively reviewed 30 ARCO stage II patients (41 hips) with ring-shaped hardening zone, and in whom follow-up was possible for at least 64 months. There were 22 males and 8 females patients, the mean age was 47 (range, 27 to 71 years), and the mean follow-up was 104 months (range, 64 to 273 months). The osteonecrosis was associated with steroid therapy, alcohol abuse or both, in twenty-one patients (70%); was idiopathic in nine (30%).

Imaging Data And Classification Of Subtypes

During the time period of this study, the evaluations were confined to magnetic resonance imaging and plain radiography. For each patient, we regularly request bilateral hip standard radiographs and frog lateral radiographs to assess the progress of the disease. The outcome in the hips with radiographic evidence of involvement was determined by a review of the records and the radiographs and was confirmed with an examination or a telephone interview. In these 30 patients with ring-shaped hardened bands, we found two subtypes which named type A and type B by us respectively by reviewing the patient's plain film data. The difference between them is that the hardened band is located at different positions on the femoral head, the hardened zone of type A is at the center of the femoral head(stay away from the weight-bearing area); the hardened zone of type B is located in the subchondral bone plate of the femoral head(near the weight-bearing area). (Fig. 1)

Data Collation

The gender, age, etiology, symptoms, and follow-up time of the patients were recorded. We listed the 32 hips that had not collapsed in Table 1, and the 9 hips that had collapsed were placed in Table 2. (The hips of some of the different cases in Table 1 and Table 2 may be from different sides of the hips of the same patient.)

Results

The fate of the forty-one hips

Initially, all of the 41 hips had radiographic abnormalities without evidence of collapse (ARCO stage II), 20 (48.8%) of the 41 hips suffered from hip pain, 18 (43.9%) of the them were painlessness, and 3 (7.3%) of the them were discomfort. Without special treatment, 9 (22.0%) of the 41 hips collapsed, 8 of them were type B and one was type A. At the last follow-up, the collapse of the 9 hips were without apparent progress. 7 of the 9 hips were asymptomatic, only 2 were discomfort. At the most recent follow-up, the 30 patients had good daily hip function, 39 (95.1%) of the 41 hips were asymptomatic and only 2 (4.9%) of them were discomfort. The survival curve of pain and collapse is shown in Fig. 2.

The Different Fate Of The Two Subtypes

In the 41 hips, there were 30 cases of type A. Only 1 of the 30 hips had collapse, with a collapse rate of 3.3%. Initially, 15 hips of pain or discomfort and 15 hips of asymptomatic. At the most recent follow-up, all of them were asymptomatic.

In the 41 hips, there were 11 hips of type B. 8 of the 11 hips had collapse, with a collapse rate of 72.7%. Initially, 8 cases of pain or discomfort and 3 cases of asymptomatic. At the most recent follow-up, only 2 were discomfort, 9 hips of the 11 hips were asymptomatic.

In order to further demonstrate the favorable prognosis of these patients, we selected partial imaging data from two patients, as shown in Fig. 3 (case 22 and case 39) and Fig. 4 (case 5 and case6).

Discussion

Osteonecrosis is a relatively common and refractory disease in orthopedics. It is a disease in which the blood supply to the femoral head is interrupted or damaged, causing a series of pathological changes such as bone sclerosis, cysts and necrosis of the femoral head. More than 80% of patients without treat will have a femoral head collapse in 1 to 3 years, secondary to hip osteoarthritis, affecting walking, and even hip replacement surgery.[15] One of the main factors affecting the prognosis of femur head necrosis is femoral head collapsing. Once collapse occurs, it is usually accompanied by pain, discomfort, and even further X-ray morphology and joint dysfunction affecting the patient's daily life. However, we also know that not all patients with femur head necrosis have a poor prognosis. Some patients with femur head necrosis have normal hip function and no collapse for a long time. [10, 11, 12] Despite the collapse, it has been suggested that in small necrotic lesions less than two-thirds of the weightbearing portion, the collapse stops, and patients whose collapse is less than 2 mm may become asymptomatic. [16] Previous studies have suggested that the necrotic type with small size and middle location has a better prognosis. [8] Some studies have proposed a new type in which cystic lesion is located anteriorly or medially, far from the weight-bearing surface has a good prognosis.[13] However, there is still international controversy about the treatment options for early and mid-term femur head necrosis or whether treatment is needed internationally. RAJPURA et al [17] believe that core decompression is currently the most widely

conservative treatment for the hip. mainly by reducing intraosseous pressure and retaining blood supply to the femoral head. The meta-analysis of LIEBERMAN et al [18] recommended the use of core decompression for the treatment of early femur head necrosis. However, no matter what kind of hip-preserving surgery, there is still no one that can guarantee the exact curative effect. At the same time, few studies have been able to indicate which type of femur head necrosis does not require treatment. Therefore, we attempted to introduce the lower collapse risk type of femur head necrosis that we found. More importantly, without special treatment, this type of femur head necrosis has a good prognosis regardless of whether it collapses or not.

The most striking finding of this study is that on the AP roentgenograms film of ARCO stage-II femur head necrosis which the hardened band is ring-shaped, whether the collapse occurs or not, usually has an ideal prognosis without special treatment. Surprisingly, type A: ring-shaped hardening zone located in the middle of the femoral head (stay away from the weight-bearing area) has an extremely low rate of collapse. At the same time, the symptoms of the type A hips usually resolve themselves within a certain period of time. type B: ring-shaped hardening zone located in the subchondral bone plate of the femoral head (near the weight-bearing area) has a high rate of collapse. Fortunately, the progress of collapse is slow, and the symptoms of type B hip are not obvious, which has no significant impact on the daily life of patients. Although there is no consensus among international experts, JIC is generally regarded as the most reliable classification and prediction method. A previous study showed that the 10-year collapse rates of different JIC subtypes were significant differences. Type A was 0%, Type B was 6%, Type C1 was 68%, and Type C2 82%.[19] Surprisingly, type A femur head necrosis described in this paper has the same low risk of collapse as Type A femur head necrosis in JIC classification. We suspect that the reason is the ring-shaped hardening zone of type A away from the load area.

After the osteonecrosis, the weight-bearing capacity of the femoral head is weakened, and the greater the mechanical force acting directly on the necrotic bone mass, the more likely it is to collapse. In our series (average follow-up 104 months, at least 64 months in each case), 32 hips (78.0%) of the 41 hips had not collapsed so far. At the same time, they were asymptomatic with good hip function. We suspect that the lower risk of collapse in such cases is most of the mechanical stress is assumed to be exerted on the surviving bone tissue while the patient was standing or walking. In addition, 9 hips (22.0%) of the 41 cases have collapsed, 8 of them have a ring hardening zone located in the weight-bearing area of the femoral head, and 1 case located in the middle of femoral head. We speculate that the cause of the collapse is because the necrotic area is located on the weight-bearing surface of the femoral head. When the patient stands and walks, the necrotic bone is subjected to a large pressure, which causes collapse. Therefore, under the same load, the type B necrotic femoral head weight bearing area may face greater collapse risk.

By observing plain radiography, we found two subtypes of the ring-shaped hardening zone, that is type A and type B. The difference between them is that the hardened band is located at different positions on the femoral head. Surprisingly, only 1 (3.3%) of the 30 hips which belong to type A had collapsed. However, 8 (72.7%) of the 11 hips which belong to type B had collapsed. Although the 9 hips collapsed,

the radiographic changes were slower. At the most recent follow-up, these 9 hips were still in ARCO stage III. Only 2 of them were discomfort, the other hips were asymptomatic. As for the reasons, we believe that the occurrence of collapse is related to the area and shape of necrosis, and we suspect that the two subtypes with ring-shaped hardening zone has more uniform or less stress on the necrotic area than the other types. However, if such a conclusion is needed, further research is needed, which is also the inadequacy of this study.

There were 23 hips (56.1%) of the 41 hips with pain or discomfort in the hip initially, however, in the last follow-up, only 2 hips (4.9%) of the 41 hips were uncomfortable. In order to more accurately determine the prognosis of the hips with femur head necrosis, we try to explain it. Because such patients with femur head necrosis are generally asymptomatic and have good joint function, no matter whether the collapse occurs or not, it does not affect the daily life of the patient. Therefore, many patients are reluctant to return to the hospital for follow-up, and we can only conduct telephone follow-up of them, which is also a shortcoming of this study. There are no regular MRI and CT scans of the patient, and there is no anatomical evidence, so it is difficult to explain why the hip symptoms are not obvious in these patients. Our next study will continue to focus on this type of necrosis to clarify the causes and mechanisms of good prognosis for this type of necrosis.

Conclusions

This study demonstrates that the ARCO stage II femur head necrosis with ring-shaped hardening zone at the middle of femoral head (stay away from the weight-bearing area) which called type A by our team have a low frequency of collapse. The ARCO stage II femur head necrosis with ring-shaped hardening zone located in the subchondral bone plate of the femoral head (near the weight-bearing area) which called type B by our team have a high frequency of collapse. Fortunately, we found that regardless of type A or type B, whether or not collapse occurred, the stage-II femur head necrosis with ring-shaped hardening zone has a good prognosis without special treatment.

Declarations

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Authors' contributions

All authors declare that all made substantial contributions to conception and design, acquisition of data, and analysis and interpretation of data. All authors have been involved in drafting the manuscript and revising it critically for important intellectual content; all authors gave given final approval of the version to be published; and all authors agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Notes

Conflict of interest

The authors declare that they have no conflict of interest.

No prior or duplicate submission or publication and no presentation of the study as an abstract at a professional meeting have been made elsewhere.

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Tables

Due to technical limitations, Tables 1-2 are provided in the Supplementary Files section.

Figures

Figure 1

The two subtypes diagram. (the hardened zone of type A is at the center of the femoral head; the hardened zone of type B is located in the subchondral bone plate of the femoral head.).

Figure 2

(A) The time of first occurrence of collapse was used as the survival curve of the end point (B) The time of last occurrence of pain was used as the survival curve of the end point. (the two cases with discomfort were classified as painless)

Figure 3

A 35-year-old man who received steroid therapy for nephrotic syndrome. (A) Frog-leg lateral radiographs and anteroposterior radiographs show bilateral hips with stage II disease at his initial diagnosis, the right is type A and the left is type B. (B) Without special treatment for three years, the patient was free from symptoms and had no collapse of the femoral heads bilaterally on frog-leg lateral radiographs and anteroposterior radiographs. (C) Five years later, the patient was free from symptoms and had no radiographic progression of the left femoral head, but collapse of the right femoral head was seen on a frog-leg lateral radiograph, not on an anteroposterior radiograph. (D and E) MRI image and CT of the suffered hip obtained at his initial diagnosis. (F) Until eight years later, the patient was free from symptoms and had good function.

Figure 4

A 50-year-old man who has idiopathic necrosis of the femoral head (A) Frog-leg lateral radiographs and anteroposterior radiographs show bilateral hips with stage II disease and type A at his initial diagnosis. (B) Without special treatment for fifteen years, the patient was free from symptoms and had no collapse of the femoral heads bilaterally on frog-leg lateral radiographs and anteroposterior radiographs. (C) Twenty-one years later, the patient was free from symptoms and had no radiographic progression of the

bilateral femoral head. (D and E) MRI image of the suffered hip obtained at sixteen years later. (F) At present, the patient was free from symptoms and had good function.

Supplementary Files

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- [Table2.xlsx](#)
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