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ORIGINAL STUDY

Reliability of serial bone scintigraphy classification according to Conway in Legg-Calvé-Perthes disease

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Serial bone scintigraphy in Legg-Calvé-Perthes disease (LCP) has a good early prognostic value. So far, no intra- and inter-observer reliability study on this classification has been published.

Serial technetium scintigraphy of the hips was performed in 40 children with LCP disease, and the hips were classified based on their scintigraphic patterns according to Conway. Forty hips were classified twice by six observers. The two assessments were made in a different order, with a minimum time interval of one month. Unweighted kappa coefficients were calculated.

Only moderate reliability was measured : intra-observer reliability : $\varkappa$ = 0.573 and inter-observer reliability : $\varkappa$ = 0.525.

Serial bone scintigraphy in LCP has an inter- and intra-observer reliability that is only moderate. The reliability is better than that observed for the radiological Catterall classification and head-at-risk factors, but worse than the reliability of the radiological Herring classification.

Keywords : Legg-Calvé-Perthes disease ; scintigraphy ; prognosis ; reliability.

INTRODUCTION

Legg-Calvé-Perthes (LCP) disease is a condition in children in which an avascular event affects the proximal epiphysis of the femur. The avascular bone is resorbed and replaced by new bone ; during this process the head tends to flatten and enlarge. Once the new bone is in place, the head slowly remodels until skeletal maturity. The condition most often affects children aged 4 to 12 years, more often boys than girls.

The disease is variable in severity. The long-term outcome in LCP is related to the shape of the healed femoral head at skeletal maturity or -maybe better- to the congruence between acetabulum and femoral head (*14, 17*). Therefore the goal in management of LCP disease is to have the best possible congruency at skeletal maturity (*13*). Treatment must be considered only for those patients who have a poor prognosis based on prognostic factors (*1, 2*). Some patients do well without treatment ; others have a badly deformed hip at the end of the disease.

Most orthopaedic surgeons use the age of the patient, the results of clinical investigation and radiographs to make a choice in treatment options (observation only, change in activities of the child,

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bracing or surgery) and to make a prognosis. For treatment to have any effect on the subsequent deformity, it must be initiated in the initial stage or at the latest in the early fragmentation stage of the disease (*3, 4, 11-13*).

A number of radiographic classifications are used to identify the patient with an anticipated poorer outcome. They are difficult to use in the early stage of the disease and most of them have low to moderate reliability (*5, 8-10*).

Conway (*7*) and Tsao *et al* (*15*) at the Children's Memorial Hospital of Chicago have developed a scintigraphic classification system, with prognostic significance which precedes radiographic changes by an average of 3 months. This classification does not describe the extent of femoral epiphyseal necrosis, but the scintigraphic patterns associated with the revascularisation in LCP disease.

Good correlation between the scintigraphic images and the radiological images observed later on has been demonstrated. Bone scintigraphy can predict very early in the disease the radiological image that will be seen at a later stage in the disease, which gives the possibility to initiate treatment earlier (*6, 15, 16*).

In order to use this serial bone scintigraphy as a prognostic tool, we studied the intra- and inter-observer reliability of the serial bone scintigraphy classification of LCP according to Conway.

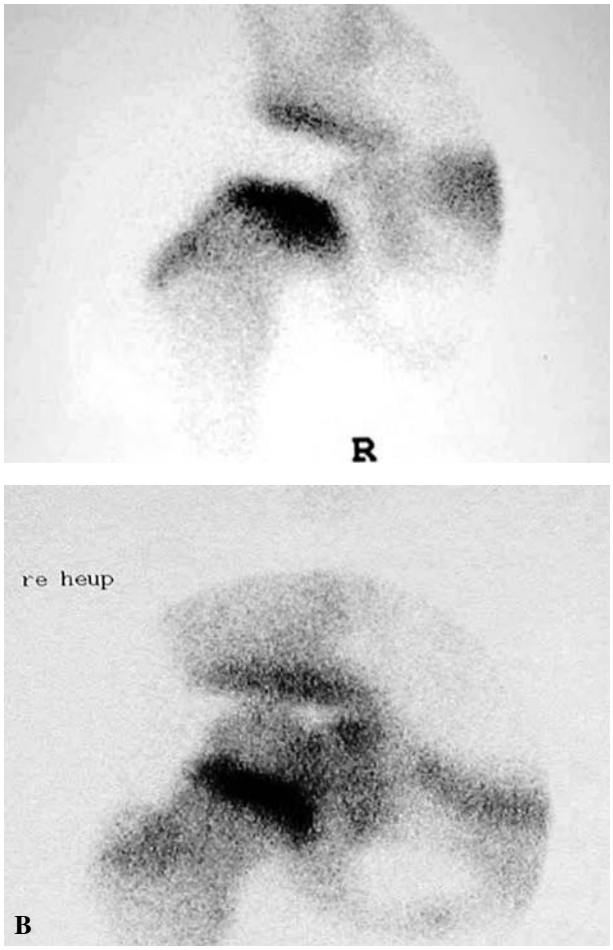

Fig. 1. — A) Stage 1. Early stage of LCP (before differentation between A and B pathway). The entire capital femoral epiphysis is devoid of scintigraphic activity. B) Normal hip.

MATERIALS AND METHODS

A set of 40 technetium bone scintigraphies of 40 different hips of consecutive cases with LCP disease was classified according to Conway by six observers. The same set of bone scintigrams in a different order was classified again by the same observers after a minimum time interval of one month. There were two paediatric orthopaedic surgeons with experience in using the classification, two orthopaedic surgeons in training with no experience with LCP disease and two specialists in nuclear medicine with experience in using the classification according to Conway. There was no specific training ; the observers were only guided by the indications from Conway with the definitions of the classification.

The Conway classification was used to describe a bone scintigraphy image of a hip with LCP disease. To have a good image of the hip we used magnified images of the proximal femoral epiphysis in the anterior and frog leg lateral projection, produced by using a pinhole collimator.

On the very early presentation (normal radiograph) the entire capital femoral epiphysis is shown devoid of scintigraphic activity (stage 1) (fig 1).

Subsequently, an A, B or C pathway is differentiated where A is a fast recanalisation of existing but thrombosed blood vessels, B is a slow neovascularisation and C is a regression pathway (*7, 15*).

In the A pathway, a lateral column (stage 2) (fig 2) followed by medial extension (stage 3) is seen. This lateral column is already present before radiographic changes or when radiographs show only a smaller dense

Fig. 2. — Pathway A (stage 2) with lateral column

Fig. 3. — Pathway B (stage 2) with base filling

epiphysis. Usually this lateral column is present 3 to 4 months after the start of the patient's symptoms.

In the B pathway we observe base filling of the capital femoral epiphysis ; the lateral column is absent (fig 3). This base filling does not present itself until the radiologic fragmentation stage, usually not before 6 months after onset of symptoms. If a patient therefore presents with advanced changes on radiographs and no scintigraphic activity in the capital femoral epiphysis, one can say that it will be a B pathway, even before base filling is seen.

In both pathway A and B a further differentiation into stage 2 till 4 is possible (evolution of recanalisation or revascularisation).

Sometimes, the lateral column disappears and is later replaced by base filling of the capital femoral epiphysis (pathway C or regression pathway).

In clinical settings, bone scan is repeated every 3 months until clear differentiation into pathway A, B or C. Two subsequent bone scans are usually sufficient.

As the hips were classified without knowledge of clinical course and duration of the disease, the following classifications were possible : stage 1 (no differentiation possible between pathway A or B), pathway A (stage 2 and 3), pathway B (stage 2 and 3) and stage 4 (end of the disease with difficult differentiation between pathway A or B). Classification for pathway C was not included, because pathway C can only be used if there is a regression from pathway A to Pathway B (with loss of lateral column), for which consecutive bone scans are needed.

Unweighted kappa coefficients were calculated to assess intra- and inter-observer reliability.

Kappa coefficients were used to be able to compare our results with those presented in studies on radiological LCP classifications (*5, 8-10*).

RESULTS

The intra-observer kappa coefficients ranged from 0.481 to 0.730, with a mean of 0.573. The more experienced observers did not have a better intra-observer score.

The inter-observer kappa coefficients ranged from 0.423 to 0.603, with a mean of 0.525.

These intra- and inter-observer reliabilities can be defined as moderate.

DISCUSSION

The observers in this study had to classify the pinhole images without knowledge of the history of the patients. In clinical practice it is important to know for how long the patient has had symptoms in order to differentiate – for example – between a long stage 1 or evolution to pathway B. So, this could have negatively influenced the reliability score.

If we compare these results with some of the radiological classification systems of LCP disease, we see that several classification methods are not always reliable. The radiological Catterall classification has an even lower intraobserver agreement

($\varkappa$ = 0.42). The presence of risk factors (some risk factors are important prognostic radiological signs) scores $\varkappa$ = 0.35. Only the Herring (or lateral pillar) radiological classification has a better agreement ($\varkappa$ = 0.78). The Herring classification has also a better intra-observer agreement ($\varkappa$ = 0.79) (*5, 8, 10*).

We know from previous studies that serial bone scintigraphy gives early information that can help in predicting prognosis and in deciding whether the patient needs treatment, even when the radiograph is still in the early fragmentation stage (*12, 13*).

Furthermore, reliability is better than for some radiographic classifications. Only the Herring classification has a good inter- and intra-observer reliability. Designing reproducible classification systems for CLP remains a problem.

We can conclude that the classification of serial bone scintigraphy according to Conway has a good early prognostic value, but a moderate reproducibility.

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