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强直性脊柱炎全髋关节置换术股骨假体的选择

Ankylosing spondylitis (AS) is a chronic inflam- matory disease with unknown causes that affects the axial skeleton and causes pain, often compromising the hip joints in advanced stage and resulting in their stiffness and fixed flexion deformity to lead to disabili- ties. Total hip replacement (THR) can significantly improve and re-establish the functions of the joints and relieve the pain, and has now been recognized as an effec- tive treatment for AS with severe hip involvement[1][3]. However, at present few reports have been available to describe the measurement of the morphological changes of the proximal femur in AS, given the importance of these changes in prosthesis selection and the long-term prognosis. In this study, the authors studied the mor- phological changes of the proximal femur and explored the significance of these changes in prosthesis selection in THR for treatment of AS.

MATERIALS AND METHODS

Clinical data

All the clinical data were obtained from the inpatients treated in Department of Orthopedics, Second Hospital of Xi'an Jiaotong University between 1995 and 2005. Twenty-four patients with AS involving 36 hips received cementless THR comprised the AS group, whose diagnosis was established on the basis of the New York clinical criteria for AS[4]. All the patients in the AS group were male with an average age of 35.2 years (ranging from 26 to 44 years), who showed severe hip dysfunction. The control group consisted of thirty patients involving 45 hips, including 19 male and 11 female patients aged from 55 to 76 years with an average of 64.7 years, among whom 10 suffered osteoarthritis involving 18 hips, 10 had femoral neck fracture involving 10 hips, and 10 had femoral head necrosis involving 17 hips.

Methods

Anteroposterior and lateral roentgenograms were obtained from each patient using a standardized technique, which must contain the isthmus of the femur for measurement of the following indices:

Singh index The singh index was classified in 7 grades, from the normal Grade Ⅶ with well-defined primary and secondary tension and compression trabeculae to severely osteopenic Grade I with only a few residual primary compression trabeculae[5]. A Singh

Index of Grade Ⅳ or lower represented abnormal bone density (osteopenia).

Canal flare index CFI was defined as the ratio of the intracortical widths of the femur at a point 20 mm proximal to the geometric centre of the lesser trochanter and at the canal isthmus (Fig. 1)[6].

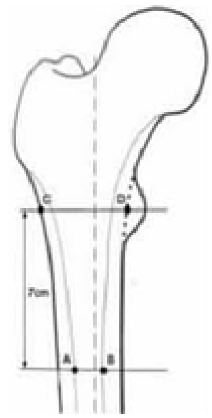

Fig. 1 Calculation of canal flare index (CFI=A/B)

Morphological index of cortex MCI was the ratio of the extracortical width at the middle of the lesser trochanter (CD) to the intracortical width 7 cm inferior to the middle of the lesser trochanter (AB), ie. MCI= CD/AB (Fig. 2).

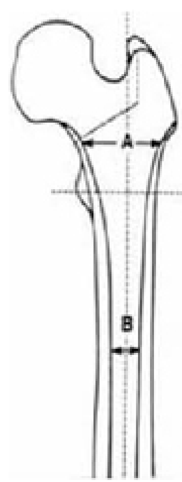

Fig. 2 Calculation of morphological index of the cortex (MCI=CD/AB)

Cortical index CI was the ratio of the extracortical width to the intracortical width at the point 10 cm inferior to the lesser trochanter[7].

Stem-canal fit According to the method suggested by Engh et al[8], the proximal femurs were divided into 3 parts designated as x, y, and z, respectively. The intra-cortical diameter of each of these 3 parts (d, e and f) was measured and their total was divided by the total of the transverse diameters of the prosthesis in these 3 parts (a, b, and c). Thus, the stem-canal fit of the prosthesis was calculated (Fig. 3).

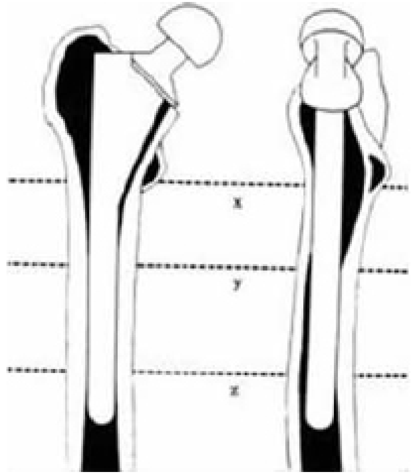

Fig.3 Calculation of stem-canal fit

The proximal femurs were divided into 3 parts designated as x, y, z, and the intracotical diameter of each of these 3 parts (d, e and f) was measured and their total was divided by the total of the transverse diameters of the prosthesis in these 3 parts (a, b, and c), ie. stem-canal fit=(a+b+c)/(d+e+f).

Statistical analysis

The data are presented as Mean±SD. Unpaired Student's t test and Spearman rank correlation analysis were used for statistic analysis and $P<0.05$ was considered to indicate significant statistical difference.

RESULTS

The roentgenograms of each patient were analyzed using Photoshop 7.0 software. As all the indices were represented as ratios, the influence pertaining to the magnification of the roentgenograms on the results could be ignored. The statistical results are shown in Tab.1.

Tab.1 Results of the statistical analysis of the measured indices between the two groups (*Mean±SD*)

Index	AS group (*n*=36)	Control group (*n*=45)
Singh index (degree)	3.83±0.64*	4.64±0.62
Canal flare index	2.69±0.39*	3.13±0.21
MCI	2.12±0.33*	2.64±0.26
Cortical index	1.69±0.69#	2.12±0.24
Stem-canal fit	75.49±5.93*	92.53±2.47

*$P<0.05$, # $P>0.05$ *vs* control group

A significant difference between the two groups was observed in Singh index ($P<0.05$), but not in the cortical index ($P>0.05$). The results demonstrated that the patients with AS had more serious osteopenia in the proximal femur, but not in the middle section of the femur (Fig.4).

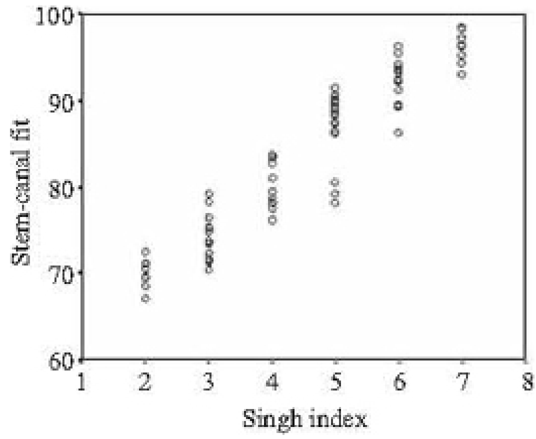

Fig.4 Correlation analysis of the stem-canal fit and the Singh index
rs=0.945, P<0.01 by Spearman rank correlation coefficient

MCI significantly differed between the two groups (P<0.05). The CFI of the AS group ranged from 2.30 to 3.08 with a mean value of 2.69, but in the control group, the value ranged from 2.92 to 3.34 with a mean of 3.13, showing significant difference between the two groups (P<0.05). The stem-canal fit of the AS group was also significantly lower than that of the control group (P<0.05), suggesting that the prosthesis failed to fit the canal well in the AS patients in comparison with the control group (Fig.5, 6)

Fig.5 Preoperative (A) and postoperative (B) roentgenograms of an AS patient treated with cementless THR
A illustrates serious osteoporosis in the proximal femur, and B shows poor fit of the prosthesis to the femoral canal

Fig.6 Preoperative (A) and postoperative (B) roentgenograms of a patient with femoral neck fracture treated with cementless THR
A shows a normal proximal femur without osteoporosis, and B illustrates a high stem-canal fit of the prosthesis.

DISCUSSION

According to Sochart et al[2], 5%-50% of the AS patients have hip joint involvement, among whom 1/3 need total hip replacement (THR). THR can effectively improve the patient's quality of life, but the controversy has not be resolved concerning what type of femoral prosthesis can be more helpful.

Controversy over femoral prosthesis selection

Some researchers believe that newly generated osseous tissues can hardly grow into the porous layer of the prosthesis for stable biological fixation in AS patients as a result of abnormal bone metabolism and osteoporosis. Sochart et al[2] reported 43 cases of cemented THR, and the results of 30-year survival proved satisfactory long-term therapeutic effect. Kilgus et al[9] also believed that cemented conventional hip prostheses could be very durable in young patients (average 43 years old).

As the AS patients can expect a long survival time and generally receive their first THR in early life time, subsequent repeated revision of THR may be required during their whole live time. The application of cemented prostheses will complicate joint revision, on the account of which many surgeons prefer cementless protheses. After a 9 to 10-year follow-up study of 81 cemented THR in AS patients younger than 45 years, Dorr et al[10] concluded that the patients' clinical satis- faction rate declined from 78% at 4.5 years to 58% at 10 years. The revision rate almost tripled to reach as much as 33%. Tang et al [11] conducted a 135.4-month follow-up of 58 AS patients (95 hips) with THR, and the results showed a total revision rate of 20% with 18% for cemented prostheses and 2% for cementless prostheses. But they did not comment on what type of prosthesis is better due to the statistically significant difference in ages between the two groups, which defied statistical comparison of the revision rate of the prosthesis.

Femoral change of the proximal section in AS patients renders cemented prosthesis more applicable

Although the currently available reports of either cemented or cementless prostheses for AS treatment showed invariably the authors' satisfaction with the clinical outcome of the patients[2][9][10][11], no investigation has been conducted to compare the therapeutic effects of the two types of prosthesis. In this study, we tried to characterize the canal morphology of the proximal femur of AS patients to provide evidence for more adequate selection of the femoral prosthesis.

Bone mass of the proximal section of the femur in AS patients In this study, we evaluated the condition of osteoporosis in the proximal femur by a simple and practical means of Singh index. A proportion of 86.1% of the AS patients suffered osteoporosis, which was found in only 8.9% of the control group. The AS patients showed spongy bone loss in the proximal femur at a faster rate. In the presence of serious osteoporosis, the micromotion resulting from the dismatch between the prosthesis and the stem canal is very likely to induce progressive prosthesis sinkage, and pain may persist. Mulliken et al[12] believed that prosthesis sinkage was associated with the bone condition.

Determination and analysis of the stem-canal fit of the prosthesis The extent of fit of the prosthesis with the femoral cortex is one of the major factors that determine the effectiveness of THR. Stem-canal fit can provide a general assessment on the fit of the prosthesis in the canal. The higher the stem-canal fit is, the tighter the combination of the prosthesis with the canal, and the less possible the complications[8] will occur. Walker et al[13] concluded that a close fit at the proximal portion of the femoral stalk must be achieved, while a loose fit is enough at the middle one-third section of the femur, and for the distal portion, a sliding fit is enough.

The mean ratio of the stem width to the intra- cortical width was 0.71 ± 0.22 at the lesser trochanter and 0.85 ± 0.29 at the isthmus in the AS group. It can been concluded that the lower stem-canal fit in the AS patients was mostly due to the poor fit of the prosthesis at the proximal femur while a close stem-canal fit was achieved at the distal femur. In fact, it was a kind of close fit in the distal femur but not in the proximal femur, which could result in higher incidence of complications. Therefore, cementless prosthesis does not suit most of the AS patients.

Determination and analysis of CFI in AS patients Noble et al[14] considered CFI between 3.0-4.7 as normal, less than 3.0 as stovepipe canal, and larger than 4.7 as champagne flute canal. Some scholars recommended application of cemented prosthesis for patients with a stovepipe canal. In the AS patient in this study, 31 patients had stovepipe canal and 5 had normal canal, accounting for 86.1% and 13.9% respectively. While the control group only had a total of 6 patients with stovepipe canal, and the remainder (86.7%) were all normal. It was found that the morphology of the canal was almost straight in the upper femur in AS patients because of thinner cortex and osteopenia.

Determination and analysis of MCI in AS patients MCI provides such information concerning the femur morphology and cortex condition. The scoring criteria is as follows: 4 scores for $MCI\leq2.2$, 2 for $2.2<MCI\leq2.7$, 1 for $2.7<MCI\leq3.0$, and 0 for $MCI>3.0$. If a patient needs long-term administration of hormones, such as one with rheumatoid or rheumatism, 1 additional score is given. If the final score is between 0 and 4, a cementless prosthesis is suitable for this patient, otherwise multiple factors need to be considered comprehensively to decide whether or not to use cemented prosthesis. The final scores of all the AS patients in this study were all greater than 4, and 83% of them had a score more than 5; in contrast, all the control patients had scores less than 4. In addition, the measurement of the cortical index showed no statistical difference between the two groups. We speculated that this was due to the fact that the AS patients suffer from severe osteoporosis causing massive bone loss in the cortical bone of the stem canal of the upper femur. This indicates good quality of the middle section of the femur in the AS patients.

Based on the above considerations, we believe that severe osteoporosis is a common concomitant condition of AS and results in notable morphological changes in the proximal femur. Cementless femoral prosthesis can not achieve good stability in the early stage following the operation, which increases the likeliness of prosthesis sinkage and thigh pains. For most patients of this kind, cemented prosthesis is recommended and the necessity of bone grafting is decided by the condition of osteoporosis so as to achieve the primary stability for the prosthesis to the greatest extent to reduce the incidence of complications.

Cementless prosthesis can achieve good effect in some AS patients

In the present study, a few AS patients were treated with cementless prosthesis, and they also had high stem-canal fit. No difference was found in the femoral canal morphology between these patients and normal subjects because the extent of osteoporosis and morphological changes of the stem canal were not obvious. For these patients, cementless prosthesis should be used.

Customized cemented prosthesis is the best choice for AS patients

Conventional THR selects prosthesis from several limited standard ones. However such factors as diseases, nationality, and sex etc. give rise to significant indivi- dual differences in the femur. Sugano et al[15] observed that the morphology of femoral canal of patients with congenital hip dysplasia was obviously different from that of normal adults. We also found great changes in the canal morphology of the proximal femur. This made the currently available types of prosthesis insufficient to meet the actual needs of the AS patients. Some proposed that computer-aided design and manufacture (CAD/CAM) of individualized prosthesis may offer an ideal and effective solution. Dujardin et al[16] proved that CAD/CAM of individualized prosthesis had advan- tages over anatomical prosthesis and customized pros- thesis in view of micromotion and stem-canal fit. For treating patients with severe hip dysplasia, Huo et al[17] resorted to customized prosthesis and achieved clini- cally satisfactory effects.

Since the patients with AS are generally not engaged in active exercise and the underlying causes of osteoporosis are not eliminated even if they have received THR, individualized cementless prosthesis may still fail to result in satisfactory long-term outcomes. We propose that individualized prosthesis be designed according to the morphology of the patient's femoral canal for a better stem-canal fit, which is also important for the cemented prosthesis. Good stem-canal fit ensures homogeneous cement distribution around the prosthesis to maintain its correct position and allows adequate conduction of stress to prevent the rupture of cement.

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