ORIGINAL ARTICLE

Soft tissue balancing in total hip arthroplasty for patients with adult dysplasia of the hip

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Objective: To summarize our surgical experience of release and balance of soft tissues around the hip in total hip arthroplasty (THA) for patients with adult dysplasia of the hip (ADH).

Methods: From January 2001 to January 2006, 29 adult patients with dysplastic hips (31 hips) were included in this study. Among them, there were 19 women and 10 men, aged from 38 to 65 years. According to the Crowe classification system, there were 8 type I, 12 type II, 6 type III and 5 type IV. THA was performed via a lateral approach. All acetabular cups were reconstructed at the original anatomic location through soft tissue releasing around the hip to restore limb length, and techniques of balance of soft tissue were applied to extend the strength of the hip abductor and improve its function.

Results: All patients had restoration of limb length (range, 1.5–4.5 cm). One postoperative dislocation occurred due to slight enlargement of the angle of abduction of the acetabulum. At 1.5-year follow-up (mean, 3.2 years) in 29 patients, the Harris score had increased from 42.6 preoperatively to 85.4. All hips were pain free with good function.

Conclusion: In order to restore the anatomic structure and physiologic function of the affected hip, the technique of release and balance of soft tissues around the hip should be applied cautiously in arthroplasty of ADH.

Key words: Arthroplasty, replacement, hip; Hip dislocation, congenital; Orthopedic procedures

Introduction

Adult dysplasia of the hip (ADH) is a common joint disease, the symptoms of which often include arthralgia, dysfunction and lameness. Total hip arthroplasty (THA) is an effective procedure for hip dysplasia, but it is sometimes difficult to complete because of femoral head dislocation, dysplasia of the acetabulum and the femur, disparity in limb length, soft tissue contraction, and muscular atrophy¹. For the past few years, we have obtained good results with THA in ADH using techniques of effective release and balance of soft tissue in order to reconstruct the true socket, partly recover the abductor and prevent resection of the femur.

Materials and methods

General data

From January 2001 to January 2006, 29 adult patients with dysplastic hips (31 hips) were included in this study.

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Among them, there were 19 women and 10 men, aged from 38 to 65 years. Preoperative anteroposterior radiographs of the pelvis and anteroposterior and lateral radiographs of the affected hip joint were taken to assess the severity of hip dysplasia and anatomic variations of the acetabulum and proximal femur. A computed tomography (CT) scan was routinely taken to identify the quality of bone around the true and the fake sockets and the shape of the proximal femoral cavity. According to the Crowe classification system², there were 8 type I, 12 type II, 6 type III and 5 type IV hips.

Initial surgical technique

THA was performed via a lateral approach. The straight approach began from 5 cm proximal to the apex of the greater trochanter and paralleled the longitudinal axis of the thigh. Skin and subcutaneous tissue were slit and the fascia lata incised lengthwise slightly posteriorly. Then the gluteus medius was exposed and separated from its one third anterior-middle parts. Parts of the sheath of the vastus lateralis were incised distally. Continuity of the aponeurosis of the gluteus medius and the sheath of the vastus lateralis were retained and repaired afterwards. The gluteus minimus was dissected from its attachment

and anterior parts of the articular capsule were exposed and incised in a 'T' shape to explore the femoral head.

Technique of soft tissue release and balance

Thickening and contractures of the articular capsule, fibrosis, scar tissue and hyperplastic osteophytes were removed thoroughly during the operation. For patients with Crowe type I or II, it was not very difficult to reduce the femoral head. At most the adductor and parts of the iliotibial tract were cut to attain this aim. For patients with Crowe type III or IV, in whom the femoral head had dislocated entirely and did not connect to the true acetabulum, the femoral heads were difficult to reduce and it was necessary to extensively release periacetabular soft tissue.

The four processes utilized were as follows: Firstly, the adductor and parts of the iliotibial tract were split and the superior attachment of the gluteus maximus to the femoral crest was released. Secondly, if reduction was still difficult, the iliopsoas muscle's attachment at the lesser trochanter was released but not abscised, and the attachments of the rectus femoris and sartorius muscles to the anterior superior iliac were released or even transected. Thirdly, release could be performed with respect to attachments of the piriformis and hamstring muscles, including the gracilis and biceps femoris, to the ischial tuberosity. Eventually, osteotomy and migration of the greater tubercle sometimes had to be performed to help reduction and extend the offset to improve abductor muscle strength by moving the greater tubercle combined with shifting the gluteus medius fixation distally. Four hips with Crowe type IV and limb shortening of more than 4 cm were reduced to the level of the true acetabulum after soft tissue release or osteotomy of the greater tubercle, preventing subtrochanteric osteotomy and resulting in no impairment of the sciatic nerve. Restoration and reconstruction of the anatomic structure of the gluteus medius and vastus lateralis were carried out at the end of operation.

Reconstruction of the acetabulum

Reconstruction of the acetabulum was achieved in place of the true socket in all cases. A regular size of biotype socket prosthesis could be placed in the true socket once it had been deepened and increased in cases with Crowe type I, II and III. For patients with Crowe type IV, the true socket was deepened backwards and inwards by a small arthroplasty reamer, retaining a thin layer of cortical bone. Then small amounts of spongy bone from the femoral head were implanted and compacted with an inversely rotating reamer. At last, a small socket prosthesis with an outer diameter of less than 44 mm and a femoral head prosthesis with a diameter of 22 mm were fixed.

Good coverage of the socket prosthesis could be achieved by techniques of true socket ingression, thus bone graft of the lateral acetabulum was avoided. A small non-cement slim shaft of prosthesis was inserted into the femoral bone. If anteversion of proximal femur was such as to render this unsuitable, rectification was made with a cement shaft prosthesis. A prosthesis with offset (LIMA-LTO, Udine, Italy) could be applied according to abductor tension to improve abductor strength and joint stability.

Postoperative rehabilitation and follow-up

The affected limb was placed in an abducted and neutral position with 70° hip flexion and 90° knee flexion. Rehabilitation of active flexion and extension of the hip joint began seven days postoperatively. Patients were generally encouraged to walk initially with crutches and other ambulation aids, with a stick six to eight weeks after surgery and eventually to give up the stick aid twelve weeks after surgery. Delay of walking time to six weeks after operation was recommended for patients with osteotomy of the greater trochanter. Twenty-nine patients (31 hips) were followed up for 1–5 years (mean, 3.2). Evaluations were made by hip joint function scores (Harris scores) and X-ray films.

Results

No early complications of palsy of the sciatic or femoral nerves, deep vein embolism, incision infection or fracture occurred. One case of femoral head dislocation occurred because the socket prosthesis was placed at a slightly larger abduction angle (50°) when the patient was transported carelessly, and this was successfully treated by closed reduction. Limb lengthening of 1.5–4.5 cm was achieved in the treatment group. No cases of loosening of prosthesis, penetration, subsidence or dislocation occurred up till final follow-up. Harris scores increased from 42.6 preoperatively to 85.4 postoperatively. Arthralgia was relieved and gaits were obviously improved.

Discussion

Pathology of soft tissue in ADH

In ADH a series of pathologic changes develop in the soft tissue around the hip joint owing to dislocation and movement upwards of the femoral head. These changes display as thickening of the capsule extending it outwards and upwards in a choanoid shape, its coherence to the lip of the dysplastic acetabulum with its narrow end, extending gradually in the direction of the femoral head and adhering to the abductor. Dysfunction of the transverse abductor leads to gait instability. Other manifestations

include pachynsis of the iliopsoas, contracture of the hamstring, adductor and rectus femoris muscles, crimping of the sciatic nerve and deep femoral artery and eversion of the outlet of the femoral nerve at the pelvis. Therefore, injury of the sciatic nerve may occur while limb extension is over 4 cm during arthroplasty³.

According to the above-mentioned pathological mechanisms, the purposes of reconstruction of soft tissue in arthroplasty for patients with ADH are as follows: (i) limb extension and acetabulum reconstruction at the level of the true acetabulum are achieved by release of soft tissue around the hip joint to abate arthralgia and produce functional impairment while avoiding injury to the sciatic nerve; and (ii) the force arm of the abductor lengthens and the tension of the adductor decreases to increase abductor strength and ameliorate claudication as much as possible.

Contribution of soft tissue release to reconstruction of the acetabulum

Up to now, most surgeons recommend prosthetic replacement in the position of the true acetabulum to recover the normal anatomic relationships of the acetabulum, preventing rapid wearing out of the prosthesis under non-physiological conditions⁴, and to lengthen the extremity so as to improve abductor function. According to the report of Linde *et al.*⁵, the data from 15 years of follow-up reveal that the loosening ratio of socket prosthesis in the position of the true acetabulum and the pseudo-acetabulum is 13% and 42% respectively.

The main characteristics of patients with Crowe type IV are complete dislocation of the hip joint and severe crimping of more than 3 cm in the affected limb. When THA is performed there is a risk of injury to the sciatic nerve with limb lengthening. Therefore, some surgeons do not recommend complete recovery of limb length but rather to utilize artificial reconstruction with mortar, with which there are obvious shortcomings⁶. Other surgeons accept subtrochanteric osteotomy for limb shortening of between 1 and 3 cm while applying a non-cement long prosthetic shaft, which can lead to difficulties in implantation, rotational displacement of the femoral shaft, nonunion of fracture and loosening of the prosthesis⁷. Kerboul *et al.* insist that there is not genuine shortening but rather a change in the pathway of the sciatic nerve in patients with Crowe type IV, and safe lengthening of the lower limb of more than 7 cm can be achieved by thorough release of soft tissue⁸. In this study, THA was performed on 30 patients with Crowe type IV and limb shortening of more than 4 cm, and the affected limb lengths were recovered by techniques of release of soft tissue without injury to the sciatic nerve. Sener *et al.*

propose that for severe dislocation of the hip joint, entire excision of the joint capsule and scar tissue is a priority, then loosening of the superior parts of the gluteus maximus, adductor, rectus femoris, and sartorius muscles is considered, and the iliopsoas muscle protected⁹.

In our opinion, limb lengthening in patients with Crowe type IV can be achieved by the technique of careful and effective soft tissue release: thickening and contracture of the articular capsule, fibrous and scar tissue and hyperplastic osteophytes should routinely be cleaned up. Then muscle groups around the hip joint can be released by four procedures: Firstly, the adductor is cut down, and parts of the iliotibial tract transected or released by a 'Z' shaped extension, then the superior attachment of the gluteus maximus to the femoral crest is released. Next, if reduction is still difficult, the iliopsoas muscle's attachment to the lesser trochanter is released but not abscised, and the attachments of rectus femoris and sartorius muscles to the anterior superior iliac released or even transected. Then, release can be performed with respect to the attachments of the piriformis and hamstring muscles, including the gracilis and biceps femoris muscles at the ischial tuberosity. Eventually osteotomy and migration of greater tubercle may need to be performed which helps reduction and extends the offset to improve abductor muscle strength by moving the greater tubercle combined with shifting the fixation of gluteus medius distally. Four cases with Crowe type IV and limb shortening of more than 4 cm were reduced to the level of the true acetabulum by the technique of soft tissue releasing with a knee flexion position. After the operation, the affected limb is set in an abducted and neutral position with 90° flexion of the knee and 70° flexion of the hip.

Balance of soft tissue in THA for ADH

In ADH lameness is caused not only by arthralgia of the hip and disparity in limb length but also by pathology of the abductor resulting in muscular atrophy and dysfunction. Dysplasia of the femoral head causes maldevelopment and augmentation of the greater trochanter whose topmost extent becomes higher than that of the femoral head. In addition, upward and outward dislocation of the femoral head results in transverse tension on the abductor which aggravates muscular weakness. Although the procedure of THA is of definite assistance in improving muscular strength and rectifying lameness, amelioration of gait and muscle strength can be achieved by balancing of soft tissue.

We pay particular attention to the following points with regard to improving muscular strength and function of the affected hip: (i) operative approach. We believe that a

lateral approach can meet the requirements of exposure and successful completion of the operation, though some surgeons consider that a post-lateral approach is better for exposure of the acetabulum. For patients with Crowe type IV, greater trochanter osteotomy can be utilized to expose the operative area clearly. Damage to the extensor is avoided via a lateral approach compared with a post-lateral approach. Thus muscle strength is protected and the incidence of postoperative dislocation is lower. The gluteus medius should be protected from too much injury and repaired together with the gluteus minimus during the operation; (ii) release of contracted muscle groups of the anterior-medial parts of the hip joint such as the adductor, iliopsoas and rectus femoris is helpful in recovery of abductor function; (iii) restoration of the anatomy of the acetabulum and reconstruction of the true socket. Reconstruction of the true socket and effective covering of the socket prosthesis in place of lateral bone implantation can be achieved with the techniques of rotator centre ingression and inner wall of acetabulum osteotomy¹⁰; (iv) the technique of trochanter migration can be performed in patients with Crowe type IV. This was introduced by Paavilainen *et al.*¹¹ and is achieved by greater trochanter osteotomy, then shifting and fixation of the greater trochanter distally and laterally to extend the strength of the abductor and improve its function; (v) an eccentric femoral prosthesis is utilized to extend the arm of the muscle, enhance the strength of the abductor and contribute to stability of the hip joint; and (vi) training of active abduction of the affected hip should be emphasized after the operation.

On the whole, satisfactory clinical results can be achieved for patients with severe ADH as follows: precise evaluation of extremity crimpation and force of abductor before operation, effective procedures for release of soft tissue around the hip to extend the limb and reconstruct the true socket, restoration of the anatomic course of the abductor and balance of its muscular strength and correct postoperative rehabilitation regimes to improve the function of the affected joint.

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