Application of soft tissue balance in total hip arthroplasty of patients with severely shortened lower limbs

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Abstract: Objective: To investigate that in total hip arthroplasty the clinical efficacy of the application of soft tissue balance in correcting lower lambs shortening of patients with severely shortened lower limbs. **Methods:** The clinical data were retrospectively analysed about 12 cases of 14 hips of patients with severely shortened lower limbs and undergone total hip arthroplasty in the hospital from February 2005 to February 2012. **Results:** All patients' limps had varying degrees of improvement, lower limbs' discrepancy were corrected, nerve function tests showed two cases of sciatic incomplete injury, recovered after three months' conservative treatment Harris score improved an average of 36.3 points, reaching postoperative 84.6 points. **Conclusions:** The application of soft tissue balance in total hip arthroplasty can solve the problem of patients with severely shortened lower limbs and relatively get lower limbs' balance.
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Total hip arthroplasty (THA) is the most effective method in rebuilding the hip joint's function. After almost half a century's evolution, with the development of surgical technique and materials science, the continuous improvement of surgical techniques and implant design, total hip arthroplasty has matured [1]. In recent years, it is generally agreed that there are many factors in surgical technique restricting the success of surgery, and soft tissue balance issues attracted more attentions of medical personnel [2]. This article aims to explore the application of soft tissue balance in total hip arthroplasty of patients with severely shortened lower limbs.

1. Materials and Methods

1.1 General Materials Selected 12 cases of patients with 14 hips severe lower limb shortening undergone total hip arthroplasty in the hospital from February 2005 to February 2012, in which Crowe Ⅲ type, Ⅳ type of developmental dysplasia of the hip (DDH) accompanied by osteoarthritis was six cases of 8 hips, femoral neck lesions and femoral head and neck absorbed caused by old fractures was six cases , leg shortened 5cm to 7cm. Use non-femoral shortening osteotomy, and only use intraoperative soft tissue balance to correct leg shortening in total hip arthroplasty. 4 males and 8 females, aged 21 to 75 years, mean 51.5 years. Up for 12 to 36 months (mean 24.6 months).

1.2 Preoperative planning For all patients measured their preoperative lower limbs discrepancy and knew their lower limb shortening situations, measured the distance from anterior superior iliac spine to the medial malleolus; using the Harris hip score system to evaluate the function and pain conditions of the hip joint; evaluated the gait, and the limp levels were divided into none, mild, moderate and severe degree; conventional hip x-ray and CT scan used to understand the true acetabular bone defects, measured the femoral anteversion angle to determine the hip rotation center [3]; in the pelvis anteroposterior film utilize the remote connection of the dacryon, the body axis, the distal vertical of light dacryon , the most salient points of lesser trochanter, the greater trochanter's high point and other anatomic landmarks and prosthesis template to determine the hip joint rotation center, acetabular cup，femoral handle and osteotomy position and to mark the following parameters: the distance between the lesser trochanter and planning rotation center; the distance between the the most salient points of lesser trochanter and planning osteotomy site; the position relationships between the thickness of planning osteotomy site's femoral neck's inner bottom and greater trochanter's high point with the planning rotation center. Mark the osteophytes that intending to remove on the acetabular rim and acetabular side bone's cyst that needs to be cut the grafted bane [4].

1.3 Operation Anesthesia and posture: all patients were treated with general anesthesia, taking positive contralateral lateral position. Using two lateral posture dam-boards and plus crosspiece in the perineum to ensure the postural stability in reset. Surgical approach and revealed: (1) skin incision: the trailing edge of the greater trochanter had a slightly curved

cambered incision about 15cm or so, the incision in the upper of the greater trochanter apex about 3-4 cm; (2) reveal and release the hip circumference: have skin and subcutaneous incision, blunt free on gluteus maximus and fascia lata's surface, along the posterior greater trochanter's crest cut fascia lata open, up along the gluteus maximus's fibers to separate them partly. After blunt dissection, the joint capsule's fat layer exposed, peel from the top of the piriformis and short supinator's dead point, cut the joint capsule, remove joint capsules and scar tissues around the fake mortar, peel the trailing edge of greater trochanter's thick dead point of released partial gluteus maximus, properly release the front rectus femoris and adductor's dead point; if necessary free down and peel iliopsoas's dead point. Pull the suffered limb to observe whether satisfied and achieved true mortar level; simultaneously, touching scar site that still need to be release, and continue to release as much as possible. When releasing the rear joint's capsule and scar, operation should be careful avoiding sciatic nerve injury. (3) Femoral neck osteotomy: hip flexion, adduction, internal rotation of the limb to reveal femoral neck astronomy site's rear neck astronomy; for lower limb shortened too much, taking the upper edge position of the lesser trochanter to have osteotomy. Completely take out the femoral head for backup. (4) Clean up and prepare the acetabulum: explore the true acetabular rim and gradually clear the scar and fat tissues that filled within the entire acetabulum. After the bony acetabular rim fully revealed, evaluate the defect site of patients with DDH, particularly on the outer edge and the front wall. Under the C-arm fluoroscopy to determine the ideal position of acetabular rotation center, with the smallest acetabular file following the decided center of concentric circles grind little cartilage and soft tissue of the mortar base and acetabular fossa, under the condition that the front and rear walls are complete, gradually grind the acetabulum until satisfied. (5) Hugh acetabular implant reconstruction and false: remove the cartilage of the amputated femoral head joint surface after trimming peripheral sclerosis and hyperplasia of osteophyte, with three kirschner temporarily fixed. From the smaller models of the acetabular file concentric circles gradually expand and burr until suitable models formed for acetabulum, shape the femoral head block into the outside wall of the acetabulum, implant the acetabular prosthesis when the mold-testing is fit. Remove the temporarily fixed Kirschner wires successively and using 2-3 pieces of 4.5 mm cortical screws replace the fixed autologous femoral bone block (Fig. 1). (6) preparation and femoral prosthesis implantation: knee femoral internal rotation 90°, so that the lower leg perpendicular to the surgical table, use the "Jaws" curved retractor to elevate proximal femur, acetabular retractors were placed in large and small trochanteric ministry to clearly reveal the femoral neck, after determining the acetabulum anteversion, grooving will be done. DDH patients often accompanied by proximal femoral dysplasia, such as spinal stenosis, intraoperation must be firstly ream manually to clear the way, must first manually reamed to clear the way, if difficulty, electric ream will be used, but operation must be under the surveillance to avoid false passage's appear, after reamed to a suitable model, implant the femoral handle. (7) Reset the hip: Reobserve the hip circumference and reset difficulty before the reset. If the reset is difficult, medical personnel should release and adjust the position of proximal femoral prosthesis as much as possible to reduce the reset difficulty. Before the reset, does the one-time and the maximum amount of muscle relaxants, and then do the hip flexor along the shortest direction of hip reset. After the reset succeed, maintain limbs hip and knees flexor position continuously and perceive proper tension of the soft tissue. (8) Incision: using absorbable PDS loop wire. Suture the stripped supinator muscle just on the trailing edge of gluteal muscle firstly. Subsequently absorbable PDS loop wire can tightly and consecutively suture the fascia lata and gluteus maximus fascia, suture the subcutaneous tissues tightly and close the incision. During the transfer process, patients' limbs were continuously maintained hip flexion 45°and knee flexion 90°position.

Figure 1: Female, 48 years old. Left: Preoperative X-ray film. The left is Crowe Ⅳ type and right is Crowe Ⅲ type of congenital dislocation of the hip osteoarthritis. Lower limbs shortened, but largely equal length. Right:

Postoperative X-ray film. The left side's reconstruction of true acetabulum used shifting technique within the acetabulum and presetting steel wire to prevent femur fracturing. Six months later, the right use of autologous bone graft structural femoral acetabular reconstruction. Postoperative lower limbs extend approximately 5cm.

1.4 Postoperative treatment: After the first treatment, began the static bed static limb training, continued to maintain limb hip flexor and knees flexor position. Then in case of causing lower limb sensory and motion abnormalities, gradually decrease the angle of the knee flexor and hip flexor. 2 weeks later, do not limit patients' activities.

2. Results

All patients were followed for an average of 2.1 years (1-3 years). There were no postoperative deaths, hip dislocation, deep infection, deep vein thrombosis and pulmonary embolism and other short-term complication through the physical examination, EMG nerve function assessment, radiographic assessment which includes measuring the hip center of hip according to the Russotti measuring method, joint infection, implant loosening, osteolysis and other complications. All the patients' claudication degrees have a varying improvement. Pre-operation: severe claudication was 8 cases, moderate claudication 3 cases, and only 1 case of slight claudication. Post-operation: moderate claudication was 1 case, slight claudication was 4 cases, 7 cases have no claudication. Preoperative lower limbs' average shortening length was 5.3cm (5-7cm). Post-operation means 1.0cm (0-1.6cm); postoperative lower limbs' discrepancy ≤ 1 cm cases were 11, 1 case was within 1~2cm. The surgery had significantly corrected the lower limbs' discrepancy as Figure 2 and Figure 3 showed. 2 cases of sciatic nerve incomplete injury symptoms had nerve function examination, and completely recovered after 3 months' conservative treatment. The Harris score improved 36.6 points, and up to 84.6 points postoperatively. Follow-up has no loosening of the prosthesis, joint infections, bone dissolution and acetabular bone nonunion and other complications.

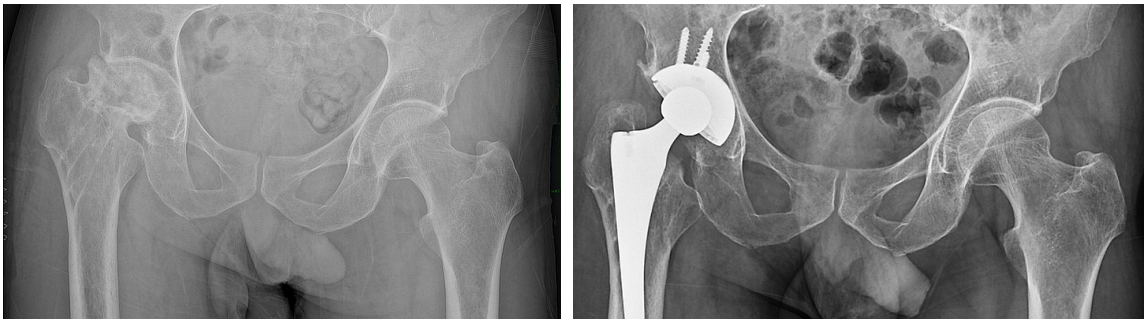

Figure 2: Male, 61 years old. Left: preoperative X-ray film. Old fracture of right femoral neck, femoral neck absorption, and right lower limb shortening 5cm. Right: Postoperative X-ray film. Lower limbs' length restored.

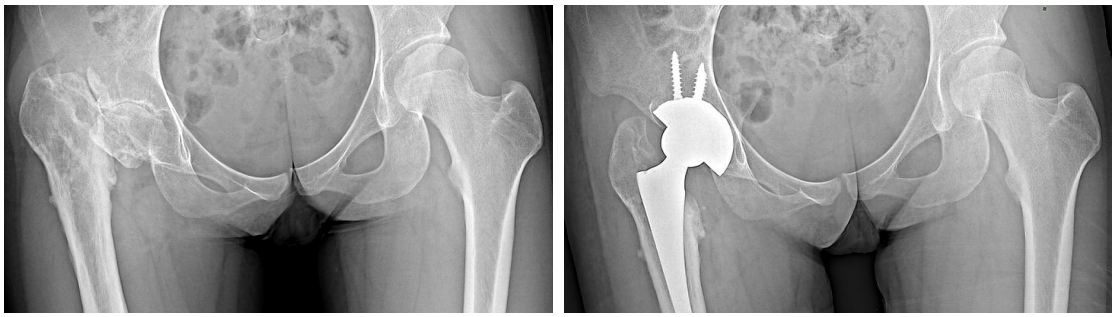

Figure 3: female, 23 years old. Left: preoperative X-ray. Suffered from septic arthritis of right hip in childhood，right femoral neck absorption, right leg shorten 7cm. Right: postoperative X-ray film, limb length restoration.

3. Discussion

Different with the transtrochanteric approach which was reported by Kerboull etc, this group adopted posterolateral approach, and did not undergo the greater trochanter osteotomy. Use of non-femoral shortening osteotomy technique will certainly increase the surgery difficulty, but reset can be achieved during the operation. Among this group of patients, only 2 patients had a transient numbness in limbs, no other serious complications. Therefore, we believe that for severely shortened lower limb patients undergoing total hip arthroplasty, we can use non femoral shortening

osteotomy technique and only use soft tissue balance approach deal with severe lower limb shortening is feasible.

The keys to reduce surgical risks line in: (1) select indications strictly: the preoperative flexion and extension of this group of patients were good, which indicated that the hip peripheral muscle, joint capsule and scar tissue must with some scalability. Otherwise, even if the released thoroughly reset can not achieved successfully, also may increase the nervous, vascular injury risk; (2) completely release around the hip: different approaches need different releasing key points and order around the hip, but all including lesions joint capsule, fibrous scar and osteophytes. Kerboull etc. [5] adopted the turn in the human way, and completely resect joint capsule, scar tissue and osteophytes to achieve proximal femur and joint reset. This group adopted posterior approach. Firstly, release and resect the joint capsule, fibrous scar and osteophytes, then successively attempts to loosen the gluteus maximums thick dead, front rectus femoris and adductor, tensor fascia lata, finally release iliopsoas. Accompanied by anesthesia with a good muscle relaxant, this group achieved a smooth prosthesis implantation and joint reduction, and no permanent damage, deep vein thrombosis and other complications appeared; (3) reasonable and good reconstruction of acetabular: current acetabular reconstruction methods include: (1) structural bone grafting, different parts' of the source autologous or allogeneic bones were used graft and fix the upper outer edge position of the acetabular [6]; (2) moves within the acetabulum, when preparing acetabulum worn its wall out and shift acetabular prosthesis within acetabulum to reach the purpose of increasing peripheral osseous coverage. (3) acetabular osteotomy, to avoid mortar bottom worn, while increasing the osseous coverage of upper edge of the acetabular prosthesis; (4) adopt smaller models of acetabular prosthesis or special designed prosthesis, gaskets to achieve complete coverage of partial prosthesis. Every acetabular reconstruction methods above-mentioned had its own shortcomings, such as bone block loose and absorption, acetabular prosthesis loosening, increased risks brought by smaller models of acetabular prosthesis's dislocation and so on. Especially when significantly extended hip to increase soft tissue's tension, causing acetabulum's stress increase, which increased the bone grafting site's mechanics and bone grafting's requirements; (4) Adjusting the position of the femoral neck osteotomy: adjust the femoral neck cut position, to some extent, can change the length of the affected side limb. This group of patients had osteotomy near the small rotor, on the one hand to avoid excessive femoral anteversion cause difficulties in proximal femur implants, on the other hand also, to some extent, reduce the length of the extension, which was conducive to reset surgery and avoided subtrochanteric osteotomy; (5) under the conditions of good muscle relaxants, hip and knees flexor adduction bit is reset: this group of patients were given general anesthesia, with two lateral position damper, and plused transverse block in perineum, ensuring postural stability reset. The hip flexion maintaining 45 ° and limb flexion 90 ° after the operation gradually reduce the flexor and knee flexion under the condition that do not cause lower limb sensory and motor abnormalities, and do not limit active motion; (6) individualized treatment plan.

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