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ORIGINAL STUDY

Total hip arthroplasty using the direct anterior approach and intraoperative neurophysiological monitoring for Crowe III hip dysplasia : surgical technique and case series

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Developmental dysplasia of the hip with a high dislocation may lead to severe hip pain and a marked shortening. Nerve palsy rates following THA in dysplastic hips have been reported as being higher by ten times or more compared to the general population. We report a new technique to perform THA in high congenital dislocations.

Between 2013 and 2015, 3 consecutive patients (4 hips) with severe hip pain and Crowe III hip dysplasia were treated. Surgeries were performed on a standard table using the DAA and intraoperative neurophysiological monitoring.

At final follow-up (mean 24 months, range 15-43), all 3 patients reported excellent pain relief and significant improvement in activities of daily living. Radiographs showed the components to be solidly fixed in satisfactory position. Average postoperative leg lengthening was 24 mm (range 20-36). None of the patients experienced an acute or delayed neurologic deficit.

Total hip arthroplasty for high congenital dislocations can be safely performed using the direct anterior approach and neuromonitoring. Significant lengthening could be obtained without neurological complications.

Keywords : hip dysplasia ; total hip arthroplasty ; anterior approach ; neuromonitoring

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INTRODUCTION

Developmental dysplasia of the hip may cause secondary incongruity due to insufficient coverage of the femoral head. In its more severe forms low or high dislocation of the femoral head may be present which has been reported attributable to up to one third of cases of hip osteoarthritis *(15)*. Adult patients with untreated DDH typically develop secondary degenerative arthritis early in life. In severely dysplastic hips (Crowe grade III en IV) the high dislocation of the hip may lead to severe hip pain and a marked shortening of the affected extremity *(7)*. In these patients, total hip arthroplasty has been proven successful in improving pain, correcting leg length and restoring joint function *(10)*. However, because of the anatomic abnormalities, THA is a technically demanding procedure in this cohort of patients.

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Contracted soft tissues, a hypoplastic acetabulum and a difficult preparation of the small narrow femoral canal all pose technical problems and early reports even considered THA contraindicated in patients with a high hip dislocation *(5,9)*. Moreover, a higher complication rate is associated with arthroplasty surgery in patients with dysplastic hip compared to patients with a primary osteoarthritis *(13,22)*. Higher rates of hip dislocation have been reported following arthroplasty for dysplasia and the deformed femoral canal increases the risk of intraoperative femoral fractures *(16,22,24)*. If limb-lengthening is necessary, sciatic and/or femoral nerve palsy remains a potential catastrophic complication. Nerve palsy rates following THA in dysplastic hips have been reported as being higher by ten times or more compared to the general population *(4,11,22)*. Several techniques have been developed to prevent nerve injuries including femoral shortening osteotomy and traction with delayed reduction *(12,14)*. Other precautions include the use of neurophysiological monitoring or performing a wake-up test in case of doubt *(10,26)*.

Several approaches, such as the lateral, posterior and transtrochanteric, have been described to perform a total hip arthroplasty in severely dysplastic hips, all with their own advantages and disadvantages. Recently, the direct anterior approach (DAA) for total hip arthroplasty has been gaining popularity as an alternative for the traditional approaches. Advantages of this approach are the use of an intermuscular/ internervous plane with no risk of denervation of the hip abductor muscles, a low dislocation rate, a reproducible component positioning and a faster early recovery *(2,17,21)*. Only one study reported on the results of THA in severely developmental dysplasia using a DAA. However, in their report, all included hips required a subtrochanteric osteotomy to avoid excessive lengthening and nerve palsy *(20)*. We report a new technique to perform THA in high congenital dislocations using the DAA and intraoperative neurophysiological monitoring, without a subtrochanteric osteotomy. Femoral head autograft was used as structural bone-grafting to the superolateral aspect of the acetabulum. Using this shelf graft technique, the acetabular component could be placed in the true acetabulum restoring the original center of rotation.

CASE SERIES

Between 2013 and 2015, 3 consecutive patients (4 hips) with severe hip pain and Crowe III hip dysplasia were treated by the senior author (ML) with a THA using DAA on a standard surgical table. All patients presented with severe hip pain and difficulties during daily living. 1 patient received a pelvic osteotomy in childhood, the other patients had no significant history of previous surgery. Non-operative treatment, including rest, physical therapy, NSAID and corticosteroid infiltrations, had failed.

Surgical technique

A standard surgical table with the possibility of hyperextension was used for all procedures. Patients were in the supine position and only the operation zone was scrubbed and draped. This allowed and simplified us to apply the neuromonitoring under the special drape (Fig. 1), while the legs remained free and leg length could visually be judged per-operatively (Fig. 2).

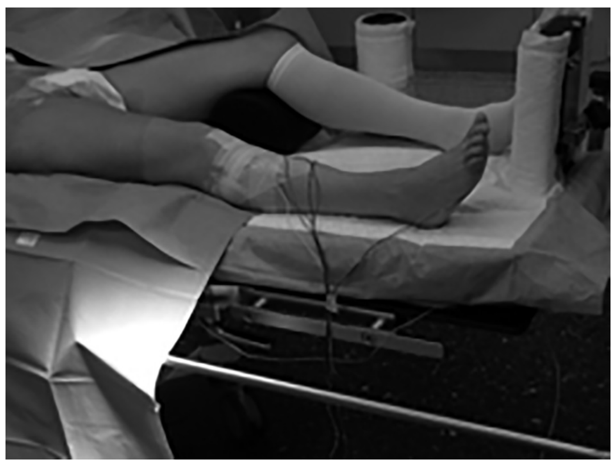

Fig. 1. — Operation table setup. For intraoperative electrophysiological monitoring of femoral and sciatic nerves subdermal needle electrodes are mounted at medial vastus, tibial anterior and abductor hallucis muscles for recording continuous EMG and motor evoked potentials after transcranial electrical stimulation as well as for stimulation saphenous, common peroneal and plantar medial nerves for recording somatosensory evoked potentials.

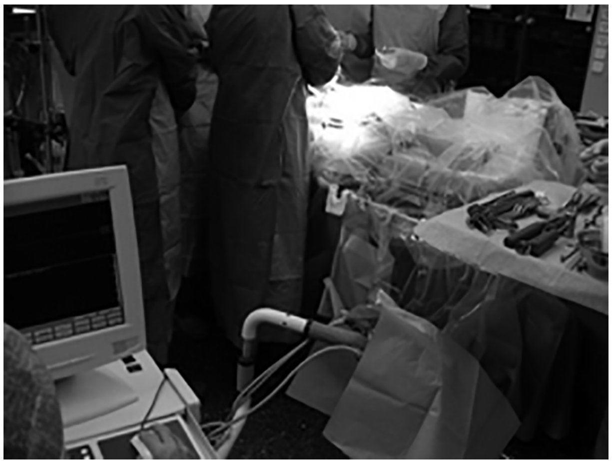

Fig. 2. — Peroperative table setup. Both legs remain free under the drapes, allowing leg length assessment and easy and fast access for mounting neuromonitoring electrodes.

A classic longitudinal skin incision (which could be easier extended) is preferred over a “bikini” incision starting approximately 2 cm laterally and distally from the anterosuperior iliac spine (ASIS) aiming towards the fibular head. In order to gain better exposure of the deformed acetabulum, the incision is extended proximally until the SIAS is exposed. After superficial subcutaneous dissection, the fascia of the TFL is incised longitudinally and deeper dissection is performed within this fascial sheath to prevent direct damage to the LCFN. The intervals between the sartorius muscle and TFL and the rectus femoris muscle and TFL, respectively, are prepared by blunt dissection. After coagulation/ligaturing of the ascending branches of the lateral femoral circumflex the hip capsule is exposed anterolaterally mobilizing the gluteus minimus and TFL laterally and the iliocapsularis and rectus femoris medially. The dislocated femoral head is identified and a subtotal capsulectomy is performed. A corkscrew device is inserted into the femoral head and the neck osteotomy is performed. After femoral head removal, the lateral capsule is released from the gluteus minimus and resected. To complete mobilization of the proximal femur, the capsule on the inner side of the lateral trochanter is released until the obturator internus tendon is exposed. Now the true acetabulum is identified (tear drop) and debrided. Sequential reaming centered to the true acetabulum is performed and component stability is assessed with a trial component. In all cases, the superolateral rim was bone deficient and reconstruction with a bone graft from the removed femoral head was necessary to obtain a solid press-fit. The removed femoral head is used as an autograft to reconstruct the acetabulum using the shelf graft technique. The residual cartilage of the femoral head is reamed away to expose subchondral bone and promote graft incorporation. The graft is now trimmed and placed at the superior edge of the acetabulum and secured with two AO 3.5mm screws. The graft is trimmed until congruent with the previously reamed host acetabulum and after trial impaction the cementless cup is inserted. Using this technique, the acetabular component was placed at the level of the true acetabulum, which was confirmed with intra-operative fluoroscopy (not used routinely for DAA THA). For femoral preparation, the operation table was hyperextended 20° to allow better visualization. A special double-pronged retractor is placed around the greater trochanter, the leg is adducted and externally rotated (figure-four position in adduction with the surgically treated leg over the untreated leg). Since the hips were completely dislocated, no release of the external rotators was necessary for adequate exposure of the proximal femur. Now gradual reaming was performed and a cementless femoral component was placed.

Two patients recieved a Polar cementless tapered fully coated stem and an R3 Socket (Smith and Nephew, Memphis, TN, US) : One patient (bilateral case) received a cemented Weber stem and an Allofit cementless hemispherical modular porous coated acetabular component (Zimmer Inc., Warsaw, IN). The bearing couple was a cobalt-chrome alloy or ceramic -on-XLPE. Perioperative antibiotic prophylaxis was routinely administered with intravenous cefuroxime. Full weight bearing was allowed on the first postoperative day. Crutches were advised for 4 weeks.

Intraoperative neurophysiological monitoring

Intraoperative neurophysiological monitoring (IONM) was done in all patients multimodal with continuous electromyography (EMG) and trans-cranial electrical cortical motor evoked potentials (tceMEP) with simultaneous recording of medial vastus, anterior tibial and abductor hallucis or gastrocnemic muscles as well as with somatosensory evoked potentials (SSEP) of peroneal nerve and tibial nerves *(26)*. All operations were performed with total intravenous anaesthesia (TIVA) with propofol (3 to 8mg/kg/h) and remifentanyl (0.3 to 0.6ug/kg/min). After induction, no muscle relaxant and no spinal or peripheral pain catheters were used to evaluate accurate IONM potentials and postoperative clinical neurological status.

RESULTS

IONM motor evoked potentials of femoral and motor and somatosensory evoked potentials of sciatic nerve (separate evaluation of pars peronealis and pars tibialis) were successfully recorded in all patients. The potentials were stable throughout the operation with fluctuation of potentials < 50% in amplitudes and <10% in latencies in all patients (fig.3 and 4).

The mean operating time was 142 min and mean total blood loss 575 ml. No complications were encountered during surgery. Postoperative clinical and radiographic evaluations were performed at 3 and 6 months after surgery and thereafter annually. Standardized AP radiographs of the pelvis and lateral views of the hip were used for radiographic examination (fig 5 and 6).

Mean follow-up was 24 months (range 15-43). All three patients reported excellent pain relief and significant improvement in activities of daily

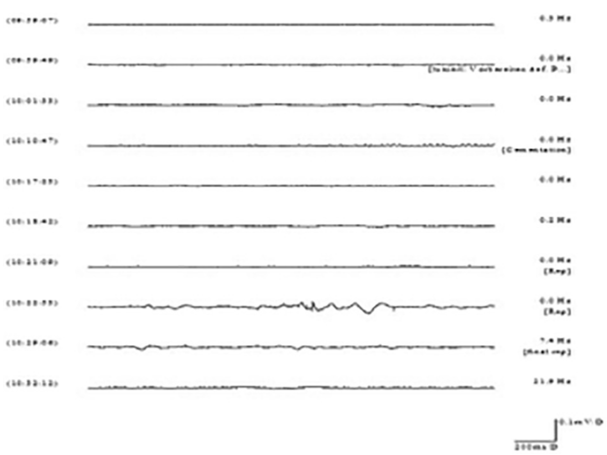

Fig. 3. — EMG recordings of anterior tibial muscle : few movement artifacts but no relevant sciatic/peroneal nerve irritation.

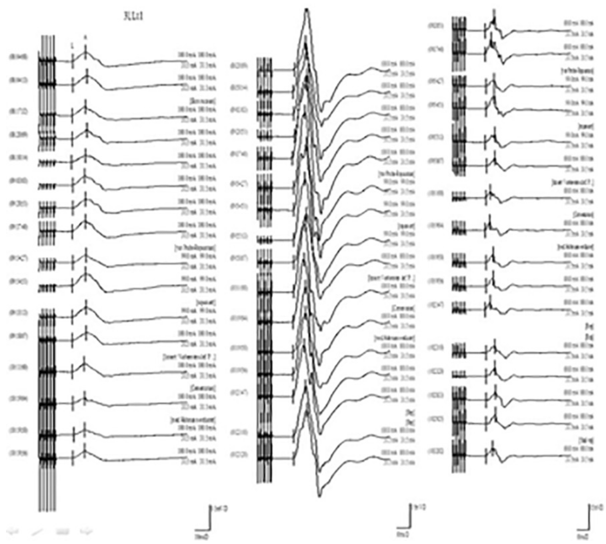

Fig. 4. — tceMEP of vastus medialis, tibial anterior and abductor hallucis muscles with stable potentials during the entire operation indicating no femoral or sciatic nerve injury.

Fig. 5. — AP Pelvic radiograph showing advanced bilateral osteoarthritis of the hips with a Crowe III high dislocation of the left hip.

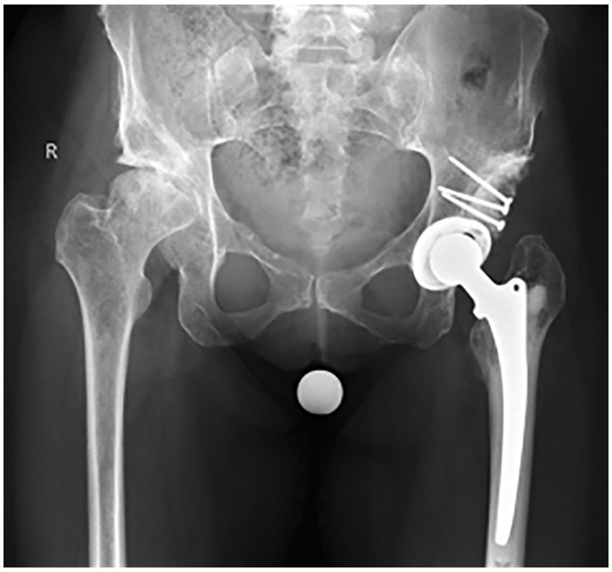

Fig. 6. — Radiograph of the pelvis 1 year after surgery, showing a good position of the components, no signs of loosening. The graft is well incorporated, no signs of bone resorption.

living. At most recent follow-up, radiographs of all 3 patients showed the components to be solidly fixed in satisfactory position. No radiolucencies or migration of the components was observed. Good incorporation of the graft was noted, without resorption. Average postoperative leg lengthening was 24 mm (range 20-36). None of the patients experienced an acute or delayed neurologic deficit.

DISCUSSION

Total hip arthroplasty in patients with a severe dysplasia of the hip is a challenging procedure with higher rates of failure and complications than standard total hip replacements *(5,7,10)*. Several techniques have been developed to overcome these potential problems using different traditional approaches, including the lateral, posterior and transtrochanteric approach. The DAA has several advantages over these traditional surgical approaches to the hip. First, it uses an intermuscular/internervous plane and does not violate the hip abductor muscles. This results in a faster recovery of hip function and gait ability compared with the posterior approach *(19)*. Moreover, preservation of the abductor muscles reduces the risk of a postoperative limp which has been described to persist in up to 66% of patients treated for a high hip dislocation *(3)*. A transtrochanteric approach has the advantage of wide access to the hip joint and the possibility of advancing the trochanter distally to improve abductor biomechanics, but is associated with specific complications, such as trochanteric nonunion and hardware irritation *(1,6)*. Using the DAA, full weight bearing could be allowed the first day after surgery and no limp was observed at final follow-up.

Another advantage of the DAA is that only the surgical field is scrubbed and draped, leaving both legs free for leg length assessment and easy access for intraoperative neurophysiological monitoring of the legs. Intraoperative neuromonitoring has been described in several publications during complex or revision total hip arthroplasty and provided highly diagnostic accuracy for sciatic and femoral nerve injuries *(8,25,26)*. This precaution helps the surgeon to avoid postoperative nerve palsy, a devastating but relatively frequent complication following total hip arthroplasty in patients with severely dysplastic hips *(4,11,22)*. When treating high hip dislocations, most surgeons prefer to use a femoral shortening osteotomy in order to avoid the risk of neurovascular damage, but this technique sacrifices femoral length and reduces the capacity to restore the length of the leg. Several suggestions have been made regarding the safe limit of limb lengthening, ranging from 2 to 4 centimeters *(13,18)*. In our case series, the increase of leg length was 2.4 cm without any nerve dysfunction observed after surgery. Using intraoperative neuromonitoring, we could safely lengthen the leg without performing a femoral shortening osteotomy, an otherwise complex and time-consuming step during the procedure. This also allowed us to avoid complications associated with the femoral shortening osteotomy, such as non-union of the osteotomy and intra-operative fractures *(14,18)*.

The major weakness of this study is the low number of patients. Larger clinical trials are necessary to confirm the safety of this technique to treat high hip dislocations. However, in our series, significant lengthening could be obtained without neurological complications.

In conclusion, we believe that total hip arthroplasty for high congenital dislocations can be safely performed using the direct anterior approach and intraoperative multimodal neurophysiological monitoring. Using this particular technique, a femoral shortening osteotomy can be avoided, an otherwise time-consuming, complex procedure with its specific complications.

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