Application of constrained implants hip arthroplasty in patients with hip neuromuscular disease

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Research Article

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Abstract

**Background:** It is well known that neuromuscular diseases increase the risk of complications after hip replacement. The purpose of this study was to investigate the clinical manifestation and survival rate of total hip arthroplasty (THA) with constrained implants in inpatients with neuromuscular diseases.

**Method:** A retrospective study evaluated the results of 17 THA in 17 patients with hip neuromuscular disease from April 2018 to June 2020. The average age at the time of operation was 66.71 years (33-86 years). The average follow-up time was 34.44 months (25-50 months). All surgery were operated through posterolateral approach. These were cementless implants.

**Result:** The incisions of all cases healed in one stage, without infection, injury of important nerves, blood vessels and other tissues, loosening of joint prosthesis and deep venous thrombosis of lower limbs. One of the patients developed a new cerebral infarction at postoperative, which affected the contralateral limb movement and seriously affect the postoperative efficacy observation. The others were followed up for 25 months to 50 months, with an average of (34.44±8.05) months. All patients underwent THA with constrained implants. The hip joint function was evaluated according to Harris Hip score standard, excellent in 2 cases, good in 12 cases and poor in 2 cases.

**Conclusion:** THA combined with constrained implants has been shown to be effective in reducing the risk of dislocation and enhancing stability for patients with neuromuscular disease.

Introduction

THA has become a mature and effective treatment for hip disease. It can effectively alleviate the pain of the affected hip and restore the weight-bearing walking function of the affected limb. In order to reduce the early complications such as pneumonia, bed sores and lower limb deep vein thrombosis in the patients especially in elderly, the key is the early operation and underground mobilization after the operation. However, for these patients with hip neuromuscular diseases, such as sequelae from poliomyelitis, sequelae from cerebral palsy, Parkinson's syndrome, hip muscle relaxation or muscle strength imbalance, their risk of postoperative dislocation is greatly increased. The change of gluteal band muscle tension will produce abnormal joint reaction, which is easy to lead to acetabular dysplasia, leg-length discrepancies and hip subluxation. These factors result in abnormal load transfer of the hip joint, leading to premature occurrence of osteoarthritis. Because of the above reasons, orthopaedic doctors who treat patients with hip neuromuscular diseases may face greater risks: aseptic loosening due to increased joint reactivity and implant dislocation due to muscle imbalance[1, 2]. So far as we know, there is little literature on the use of constrained implants in the treatment of hip disease in these patients with neuromuscular disease. Therefore, the retrospective research reviewed a series of patients with hip neuromuscular disease who received constrained implants THA for hip disease to evaluate the clinical efficacy.
Method

From April 2018 to June 2020, 17 THA used constrained implants had been performed on 17 patients with neuromuscular disease.

The patients involved 8 males (47.06%) and 9 females (52.94%), with 5 right hips (29.41%) and 12 left hips (70.59%). The average patients' age was 66.71 years (range 33–86 years). Of the 17 patients, 10 patients had cerebral palsy, 7 patients had poliomyelitis. 7 patients were treated for femoral neck fracture, including 2 cases complicated with poliomyelitis and 5 cases of cerebral palsy; Fracture types: Garden II in 2 cases, Garden III in 4 cases and Garden IV in 1 case. 8 patients were treated for developmental dysplasia of the hip (DDH), including 5 cases complicated with poliomyelitis and 3 cases of cerebral palsy. 2 patients were treated for dislocation after hemiarthroplasty (HA), both of them were complicated with poliomyelitis. One of them was admitted to a local hospital for treatment of right femoral neck fracture (Garden III) and received right HA. On the 5th day after surgery, the prosthesis was dislocated, the doctor immediately performed closed reduction and tibial tubercular traction were performed for 45 days. And the prosthesis was dislocated again 6 days later, so he came to our hospital.

After hospitalization, all patients took the preoperative examination and treatment of basic medical diseases. For patients with basic medical diseases, actively ask relevant departments for consultation and assistance. Such patients often accompanied by hypertension, diabetes mellitus etc. we should adjust their blood pressure and blood glucose, and prevent thrombosis according to anticoagulation guidelines, so as to improve the safety of surgery and reduce perioperative risk. Pre-operative planning was routinely used in all patients.

The operation was performed under general anesthesia or spinal anesthesia. All were performed by a group of senior surgeons through the posterolateral approach. Every patient lay on his side on the operating table, and the limb of the affected side is up. A surgical incision of about 9cm was made along the posterolateral side of the large rotor. The muscle tissue was cut layer by layer and t-tomy was performed after exposing the joint capsule. Osteotomy of femoral neck according to prosthesis after dislocation of hip joint (In 2 cases of dislocation after HA, to remove the prosthesis). After the femoral head segment was removed, the acetabulum was prepared with a spherical reamers. When the bone in the acetabulum obtained satisfactory bleeding, the reaming was stopped. The prosthesis model was implanted to check the fitness of the prosthesis and the close contact with the bone. Insert the acetabular cup at an ideal inclination of about 30–50 degrees and a forward inclination of 10–35 degrees. This process requires attention to the front overhang of the cup. The femoral head prosthesis was strongly pressed into the constrained liner. All cases were treated with cementless femoral stems. Reduced the joint carefully and sutured the muscles layer by layer and finally the skin. Unless there are contradictions, tranexamic acid should be routinely used during perioperative period. Participants receiving tranexamic acid regimen received two intravenous injections, one (1 g) after anesthesia and the other (1 g) during wound suture. All participants received the same rehabilitation program, and the patients could carry some weight with crutches after operation. According to the clinical pathway of THA, the same anti
infective, antithrombotic and analgesic treatment is provided for all patients. All cases were treated with the third generation cephalosporins for short-term antibiotic prevention, and low molecular weight heparin was used to prevent venous thromboembolism on the first day after operation. Before operation, the degree of flaccid paralysis was evaluated and the hip periarticular muscle strength was recorded. From the first day after operation, physical therapy was performed through passive movement. Isometric exercise is encouraged from the 3rd day after operation. If possible, we also recommend that the patient try to go down to the ground with crutches the next day after operation. Patients were discharged after an average of 4 to 5 days in hospital. In the first month, it is allowed to use two crutches to carry weight partially, and then carry weight completely if allowed.

All patients used the same acetabular cup. There is less mobility between the outer surface of this constrained liner and the inner surface of the acetabular cup. However, it provides greater mobility between the inner surface of the constrained liner and the femoral head prosthesis. All femoral stem prostheses were uncemented. All femoral head prostheses were metal.

Radiology and clinical evaluation were performed by lateral and anteroposterior X-ray and Harris hip score (HHS). The time of examination is before, after operation, 1 month postoperation, 3 months postoperation, 6 months postoperation, and once a year after surgery[3].

Taking the maximum diameter of the prosthesis head as a reference, the image magnification was calculated to measure the difference in leg length. Measure the distance between the tear line on the front and rear radial lines of the pelvis and the top of the lesser trochanter. At the last follow-up, imaging measurement was performed by measuring the orientation of the femoral stalk and acetabular cup, heterotopic ossification, and osteolysis. Measure the orientation of the acetabular cup on the X-ray of the pelvis[4]. Pericup osteolysis is defined as fan-shaped erosion with a diameter of more than 2 mm at the interface of the bone prosthesis; The gradual widening of the light transmission line by more than 2 mm or and the deviation by more than 5 ° or 2 mm is considered as the loosening of acetabular cup[5].

Result

The demographic and baseline characteristics of enrolled patients are listed in Table 1. However, a patient had a new cerebral infarction in the afternoon after operation of the second day, and we transferred him to the neurology department for treatment (Fig. 1). Because it affects contralateral muscle strength and postoperative efficacy observation seriously, so we dropped his follow-up. The others were followed up for 25 months to 50 months, with an average of (34.44 ± 8.05) months. Compared with 7.56 before operation, the mean visual analog scale pain score (VAS) became 1.81 after operation (p 0.001). The Harris Hip score increased from 31.25 before operation to 76.38 after operation (p 0.001)(Table 2). There were 2 excellent cases, 12 good cases and 2 poor cases. The X-ray anteversion angles of 17 patients were within the safe range (15 ± 10°). No dislocation of femoral stem and acetabular component occurred. The discrepancy of mean leg length after operation was 1.37 ± 0.60 cm. No evidence of heterotopic ossification and aseptic loosening of prosthesis was found (Fig. 2). There
were no cases of nerve palsy, deep vein thrombosis, dislocation and periprosthetic infection during the recent follow-up.

**Table 1** Demographic data of patients

<table>
<thead>
<tr>
<th>Variables</th>
<th>Constrained implants THA in patients with hip neuromuscular disease (n=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>66.71±9.99</td>
</tr>
<tr>
<td>Gender</td>
<td>8(M): 9(F)</td>
</tr>
<tr>
<td>Muscle strength</td>
<td>2(I): 10(II): 5(III)</td>
</tr>
<tr>
<td>Prior surgery</td>
<td>2(yes): 15(no)</td>
</tr>
<tr>
<td>Operation time</td>
<td>74.65±9.51 minutes</td>
</tr>
<tr>
<td>Blood loss</td>
<td>112.06±22.36 ml</td>
</tr>
<tr>
<td>Hospital stay</td>
<td>12.29±4.81 days</td>
</tr>
</tbody>
</table>

**Table 2** Clinical outcomes (n=16)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Pre-operation</th>
<th>Last follow-up</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAS score</td>
<td>7.56±1.09</td>
<td>1.81±0.75</td>
<td>0.001</td>
</tr>
<tr>
<td>Harris score</td>
<td>31.25±7.93</td>
<td>76.38±7.66</td>
<td>0.001</td>
</tr>
</tbody>
</table>

**Discussion**

The purpose of this study is to investigate survivorship and clinical manifestation of THA using constrained implants in patients with neuromuscular disease. We often encounter osteonecrosis of the femoral head (ONFH), DDH or fracture of femoral neck combined with neuromuscular disease, such as hemiplegia after stroke, sequelae of poliomyelitis and Parkinson's syndrome. The hip disease of such patients is a challenge for surgeons due to the morphological changes and sequelae of these diseases. The deformities that occurred around the hip joints, usually due to muscle imbalance. Degenerative osteoarthritis may occur in normal contralateral or paralyzed hip joints because of increased stress on the joint[6]. Furthermore, osteoporosis often occurs due to decreased muscle strength and asymmetric flaccid paralysis[7]. Patients with long-term lower limb weakness have poor mobility, so their bone mineral density is generally low, and they are more prone to fracture after minor trauma[8]. Factors such as prosthesis position, soft-tissue tensioning and prosthesis design can determine the incidence of...
postoperative hip dislocations[9]. Such surgery need careful preoperative planning because it predicts potential intraoperative challenges in THA. It should be noted that due to the inherent limitations of hip neuromuscular diseases, the use of common indicators (for example, the Harris Hip Score) to evaluate the surgical results may be impaired, and should not be the reason to treat the results as failures. For instance, limb length differences, muscle weakness, residual claudication, and muscle pain are characteristics of neuromuscular diseases that may affect the evaluation scale of THA results. But these can lead to improved quality of life and better functional recovery, so the surgery could not be regarded as failure. Therefore, when evaluating the effectiveness of the surgical intervention in patients with neuromuscular diseases, the benefits of surgery for individual patients should be considered. Physical and occupational rehabilitation is important for patients with hip disease to obtain the best effect after THA. Rehabilitation should be started on the first day after operation, and muscle strengthening plan should be implemented to obtain the maximum functional effect[10]. Postoperative care is important. In this study, one patient developed cerebral infarction in the afternoon of the second day after operation, which affected contralateral limb activities. We transferred him to the neurology department for treatment, and finally we had to give up his follow-up. Studies show that multidisciplinary care for elderly patients who suffered from hip fractures can improve the survival rate and make the mortality trend downward[11].

Lutonsky et al. reported THA in 17 patients with cerebral palsy, 15 out of the 17 patients were examined. In this study, one patient died and one failed to attend, 4 patients were dislocated, and 2 patients had postoperative infection and pararticular ossification. 7 patients were able to walk with a wailer, and 8 patients had severe difficulties or were in a wheelchair[12]. The outcome of the operation was not satisfactory. Yoon et al. treated 10 patients with poliomyelitis through THA. All patients had improved function and reduced pain, but one hip dislocated. The postoperative hip pain was significantly relieved and the function was significantly improved, indicating that THA is feasible and effective in the treatment of painful hip joints with neuromuscular disease[13]. It is necessary to select a correct surgical procedure and implant in order to obtain good results. Choosing the appropriate implant is a key to successful operation.

Ideally, unconstrained tripolar hip implants need to reduce dislocation rates by improving range of motion before hip prosthesis impact occurs[14]; However, there are some concerns about these implanted prostheses, such as component detachment and increased wear[15–17]. Several strategies were implemented in patients with neuromuscular disease, and the results were compared. In order to reduce the risk of postoperative hip dislocation, the use of constrained acetabular components has been proposed[18]. In the revision surgery of 54 cases of recurrent hip instability, Guyen et al. used an unconstrained tripolar hip implant in a patient with polio residual sequelae, although the patient was 80 years old. In the second month after surgery, the dislocation of hip prosthesis was caused by the patient sitting on a chair and picking up things from the floor[19]. Munro et al. Used a limited liner prosthesis in a patient with residual poliomyelitis sequelae, and there was no dislocation or other complications during the follow-up period[16]. In this study, a patient developed dislocation after HA, which was ineffective
after traction treatment. Therefore, when we used constrained implants for this patient, the postoperative hip function of the patient improved, and there were no dislocation or other complications.

This study has some shortcomings. Firstly, there are few patients with hip neuromuscular diseases. Most of them do not pay attention to the hip joint function of the affected limb. Few people are willing to have a hip replacement. So the number of patients included in this study is not sufficient. And the strength of statistical analysis may not be enough to draw conclusions. But, we believe that our findings provide useful information. Secondly, this study is a retrospective study. Not all cases have the same follow-up results due to different treatment time, different operation time and different follow-up time. However, the shortest follow-up time for this study was 25 months, and the average follow-up time was 34.44 months. Third, the patient's muscle strength is obtained by many surgeons from their recent clinical records according to their experience, and there may be measurement deviation. According to the results of the study, THA can be used as a treatment option for hip diseases in patients with neuromuscular diseases. Since there have been a large number of reports about hip prosthesis dislocation, prosthesis loosening and even parts breaking or falling off after THA, we recommend that patients with hip neuromuscular diseases use restraint devices.

Conclusion

In conclusion, the results of our study for an average of 34.44 months shows that the clinical results were satisfactory, the functional scores were improved, the radiographic results were good, and the survival rate were good. THA combined with constrained implants can effectively reduce the risk of postoperative dislocation in patients with hip neuromuscular diseases, and effectively improve the stability of the artificial joint. Therefore, for patients with neuromuscular disease, THA with constrained implants is a good choice for the treatment of hip disease.

Declarations

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Not applicable

Author contributions


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Availability of data and materials

The data sets generated and/or analyzed in the current study are not publicly available due to patient privacy, but can available from the corresponding author in reasonable request.

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study and the subject described in this report. Protocol approved by the Medical Ethics Committee of the Third Hospital of Hebei Medical University.

Consent for publication No applicable.

Competing interests The authors declare no competing interests.

References


Figures
Figure 1

a: The patient was a 74-year-old male with left femoral neck fracture combined with cerebral palsy. b: After THA (used constrained implants). c: Preoperative DWI showed old cerebral infarction. d: Postoperative DWI showed multiple acute infarcts in left frontal lobe, basal ganglia and lateral ventricle.
a: The patient was a 51-year-old male with right femoral neck fracture combined with cerebral palsy.

b: Thirteen months after constrained implants HA, his radiograph showed no signs of osteolysis or implant loosening. c: A 63-year-old woman with cerebral palsy experienced dislocation after THA in the right hip. d: Fourteen months after constrained implants THA, her radiograph showed no signs of osteolysis or implant loosening.