Case Report

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Muscle and physical functions after one-stage total hip arthroplasty with shortening subtrochanteric osteotomy in an old-old patient with bilateral Crowe IV developmental dysplasia dislocated into the gluteal muscles: a case report

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Introduction and importance: Although developmental dysplasia of the hip (DDH) patients aged over 80 years are occasionally encountered in Japan, most of them have severe deformity with complete dislocation and have not received any treatment in childhood. Therefore, surgical treatment for such patients remains extremely challenging, and few detailed reports have described postoperative muscle recovery and rehabilitation outcomes in this age group.

Case presentation: The patient was a woman in her 80s who had bilateral Crowe IV DDH dislocated into the gluteal muscles without a history of DDH treatment. She experienced walking difficulties due to aging and had elements of sarcopenia. One-stage bilateral total hip arthroplasty (THA) with shortening of the subtrochanteric osteotomy was performed.

Clinical discussion: The gluteal and knee extensor muscles in THA with shortening subtrochanteric osteotomy for Crowe IV dysplasia in old-old patients differ from those in conventional long-term outcomes; consequently, physical and gait performance did not reach the cutoff values for fall risk at several points.

Conclusion: Long-term intervention that considers multidisciplinary aspects is necessary for postoperative rehabilitation for one-stage bilateral THA with shortening subtrochanteric osteotomy in old-old patients with sarcopenia.

Keywords: leg lengthening, non-treated developmental dysplasia of hip, one stage, shortening subtrochanteric osteotomy

Introduction

Developmental dysplasia of the hip (DDH) is prevalent in Japan[1], with the Pavlik harness as the standard treatment for acetabular dysplasia in newborns or infants. Delayed treatment renders dysplasia correction with orthotic therapy difficult, necessitating osteotomy[2]. The Research on Osteoarthritis /osteoporosis Against Disability: ROAD study[3], a 10-year follow-up survey on the prevalence of hip osteoarthritis (OA) diagnosed by radiographic examination in Japan, identified aging, obesity, and acetabular dysplasia in the initial examination as risk factors for OA progression. DDH-OAs are divided into two types: cases with a hip joint dislocated from the acetabulum and in contact with the bone surface, and cases with a hip joint dislocated from the acetabulum and not in contact with the bone surface, which is located in the gluteal muscles. Historically, surgical intervention for a dislocated hip into the gluteal muscles is avoided because of perceived difficulty. In the 2010, several studies reported good long-term results[4,5] and feasibility[6] after total hip arthroplasty (THA) with shortened subtrochanteric osteotomy.

Japanese nationwide "Prevention campaign for DDH in newborns" was held from 1972 to 1973. A survey of the

HIGHLIGHTS

- One-stage bilateral total hip arthroplasty (THA) with shortening of the subtrochanteric osteotomy has been reported as a procedure with good long-term results and feasibility.
- The elderly patient after this surgery had good recovery of knee extensor muscle strength and mass, but not for hip muscles.
- The gluteal and knee extensor muscles in THA with shortening subtrochanteric osteotomy for Crowe IV dysplasia in old-old patients differ from those in conventional long-term outcomes.

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history of DDH treatment in childhood by birth year showed that Japanese newborns before 1945 were mostly untreated for DDH, and the study indicated that all patients with Crowe type III and IV were born before the campaign[7]. Currently, untreated newborns or infants are uncommon in Japan. Conversely, clinical practice often encounters patients aged >80 years who, owing to untreated DDH from infancy (often born before 1945), present with difficulty in walking as they age. Although favorable long-term outcomes of THA with shortening subtrochanteric osteotomy have been reported in younger patients[4–6], its applicability and postoperative rehabilitation strategy for old-old patients with untreated DDH and sarcopenia remain unclear. This case report has been reported in line with the SCARE checklist[8].

Case history

Preoperative conditions

The patient was a woman in her 80s who had bilateral Crowe IV DDH dislocated into the gluteal muscles (Table 1). Although she had severe limping and hip contracture, she had been pain-free since childhood. Five months preoperatively, the patient had fallen, which caused difficulty in ambulation, anxiety and low self-efficacy; therefore, the Japanese Orthopaedic Association Hip Disease Evaluation Questionnaire (JHEQ)[9] score was very low (Table 1). The bilateral hip joints were dislocated proximally 8 cm from the true acetabular position and into the gluteal muscles without the bone contact surface (Fig. 1).

Table 1

Demographic data of the case

Age (years)	82
Sex	Female
Height (cm)	139.5
Weight (kg)	39.1
Body mass index (kg/m^2)	20.9
Hospitalization after surgery (days)	116

Surgical procedure

Preoperative planning was performed using the computed tomography-based navigation system, OrthoMap (Stryker Japan, Tokyo, Japan). This study used cementless acetabular and cemented femoral components. To prevent sciatic nerve palsy due to leg lengthening, the planned lengthening was to be within 4 cm, including distal femoral shortening osteotomy (Fig. 1).

The procedure was performed under general anesthesia with the patient in the lateral decubitus position. A posterolateral approach was used, following the method described by Yasgur *et al*[10]. Two tracker pins were inserted into the iliac crest, and their recognition by the navigation system was confirmed. A skin incision of approximately 20 cm was made along the femur, starting from the tip of the greater trochanter. The short external rotators were identified and detached from the piriformis and quadratus femoris muscles. The psoas and gluteus maximus insertions were released, and the joint capsule was incised to resect the femoral head.

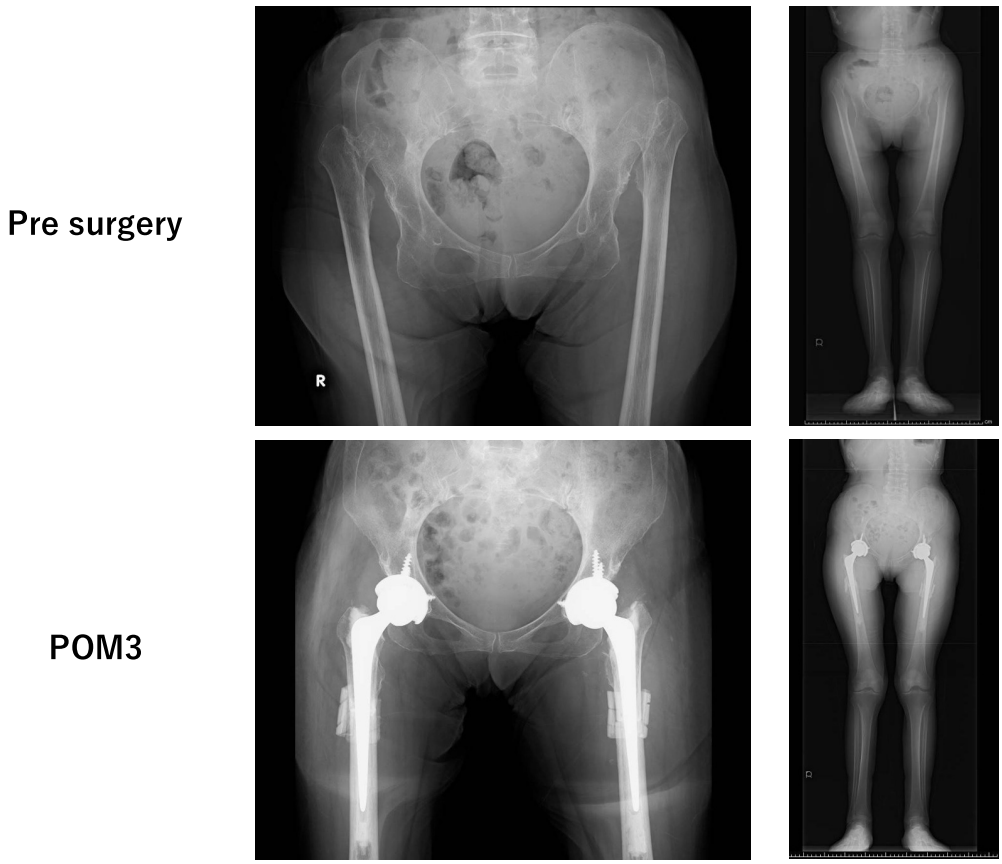

Figure 1. Radiographic pictures before and after surgery.

The pelvic registration for the navigation system was performed using paired point and surface matching. The acetabulum was reamed under navigational guidance, beginning with a 38-mm reamer and ending with reverse reaming. A 44-mm Trident II acetabular shell was implanted with 15° of anteversion and 40° of inclination as per navigation guidance and achieved good fixation with a press-fit and four additional screws. A 32-mm liner was inserted.

On the femoral side, the vastus lateralis was elevated, and a transverse osteotomy was made 20 mm below the lesser trochanter. The resection length was determined based on preoperative planning and intraoperative manual traction of the lower leg. The overlapping length of the fragments was measured, and a proximal femoral shortening osteotomy of 40 mm was performed. Femoral anteversion was adjusted using the gluteal tuberosity as a landmark, and the stem was cemented using third-generation cementing techniques[11]. The excess cement was carefully removed from the bone fragments. The excised autologous cortical bone was split longitudinally, placed around the osteotomy site, and secured using two polyethylene cables. The total operative time was 3 h and 50 min, and the total blood loss was 867 mL.

Convalescent rehabilitation

Convalescent rehabilitation was conducted twice daily by a physiotherapist. As the pain was relieved, the Harris Hip Score (HHS), an objective outcome measure, progressed over time. In contrast, the JHEQ, a patient-based outcome, improved, but the recovery rate of the JHEQ score was slower compared to the HHS score, as the mental score, a subsection of the JHEQ, stagnated (Table 2).

Progress of recovery by muscle strength

Until postoperative month (POM) 2, the muscle strength was very poor, therefore, the isometric muscle test was not conducted. Knee extensor strength progressed over time, and the leg strength reached the cutoff value of independent walking for nursing home residents (0.6 Nm/kg)[12] on POM 3. Moreover, hip abductor strength was almost constant and did not increase from POM 2 until discharge. Neither leg strength reached the cutoff value for fall risk (1.0 Nm/kg)[13] on POM 4 (Table 2).

Grip strength is used to diagnose sarcopenia and frailty as a representative value of the musculature condition of the whole body[14]. In spite of an acceptable nutritional status, grip strength was constant and did not increase from POM 2 until discharge, similar to the hip muscle (Table 3).

Alteration of muscle mass and intramuscular fat

Muscle mass, thickness, and intramuscular fat of the quadriceps femoris muscle were measured in the supine position using an ultrasonic reflectometer at a proximal 10-cm point to the top of the patella every month from POM 2–4. The mass and thickness of the knee extensor muscles increased over time, whereas the intramuscular fat in the rectus femoris muscle (RF) remained almost constant (Fig. 2, Table 4). Because of the difficulty of identification with landmarks owing to the underdevelopment of the pelvis, the cross-sectional area of the gluteus maximus and medius muscles was measured on a slice at the top tip of the greater trochanter (Fig. 3).

Physical and gait performance

The timed up and go test (TUGT), functional reach test (FRT), and Five Times Sit to Stand Test (FTSTS) were performed. Physical performances were improved over time (Table 2), but had not reached the cutoff values for fall risk regarding TUGT and FTSTS (TUGT >13.5 s; FTSTS ≥12 s; FRT >18.5 s)[15–17]. Similarly, gait performance did not reach the cutoff values for fall risk (1.0-m/s)[18] and a consensus value for sarcopenia with limited mobility (<400 m) (Table 2)[19].

Discussion

This case demonstrated the feasibility of applying a technically established procedure, THA with shortening subtrochanteric osteotomy, to an old-old patient with Crowe IV DDH and sarcopenia. While the surgical technique itself is not novel, the postoperative course and recovery

Table 2

Alteration of hip scores, lower limb strength, and physical performance

	Side	Pre-surgery	POM1	POM2	POM2.5	POM3	POM3.5	POM4
Harris Hip Score (point)	Right		17	41	56	57	51	57
	Left		18	42	62	70	74	67
JHEQ Score (point)	Right	13	NA	35	42	40	45	49
	Left	16	NA	35	43	42	45	49
Knee extensor strength (Nm/kg)	Right		Unable	0.42	0.58	0.77	0.70	0.87
	Left		Unable	0.43	0.50	0.71	0.66	0.57
Hip abductor strength (Nm/kg)	Right		Unable	0.55	0.41	0.62	0.61	0.55
	Left		Unable	0.56	0.58	0.62	0.63	0.58
5 Times Sit to Stand Test (sec)			Unable	Unable	48.04	24.96	17.1	17.1
Functional Reach Test (cm)			Unable	20.6	23	27.3	25.3	25.3
Timed Up and Go Test (sec)			Unable	Unable	28.3	23.9	25.1	25.1
10-m Timed Gait Test (sec)			Unable	23.6	24	21.5	19	19
Gait speed (m/sec)			Unable	0.42	0.42	0.47	0.53	0.53
6-min gait distance (m)			Unable	Unable	120	150	150	150
Functional independence measure (point)			52	56	77	78	80	80

Table 3

Assessment of sarcopenia and nutritional status

	Pre-surgery	POM1	POM2	POM2.5	POM3	POM3.5	POM4
Sarcopenia (positive: P or negative)			P	P	P	P	P
Grip strength (dominant side)			17	18.5	18	16.5	17
Maximum circumference of the lower leg							
Right side (cm)			24	24	25	24.5	24.5
Left side (cm)			25	25.5	26.5	27	26.5
Nutritional status							
Energy intake (kcal)			1013	1163	1208	1286	1272
Energy consumption (kcal)			1072.8	1116.8	1128.9	1128.9	1128.9
Albumin (g/dL)	4.5	3.9	4.5				
Total protein (g/dL)	6.8	6.5	6.9				
C-reactive protein (g/dL)	0.04	0.04	0.04				

characteristics in this demographic have rarely been detailed in the literature. The length-tension curve[20,21] in the muscles improved because of a correction of the greater trochanter 8 cm distally. Even after the length-tension curve in the muscles was corrected to a normal value, the recovery of hip abductor muscle strength remained constant at 0.5–0.6 Nm/kg. Although nutritional status and nutrient intake can affect sarcopenia[12], the patient's energy balance remained positive after POM 2.5. The reasons for prolonged hip muscle weakness were as follows: 250 kcal per day of excess energy, which is needed to gain 1 kg of body weight in a month, was not met[22], and protein intake is reportedly related to lower limb strength 1 year after THA[23]. Therefore, it may be necessary to conduct prehabilitation for high-risk patients with prolonged muscle strength weakness[24].

However, the effect of leg lengthening on the knee extensor muscles was limited, and the cross-sectional area of the RF and quadriceps femoris muscle thickness recovered over time. Regarding hip function, the mental component of the JHEQ, which reflects self-efficacy, has been reported to be related to POM 6 abductor muscle strength in THA[25], and the relationship between abductor muscle strength and patient-based outcomes supports the findings of a previous study.

The long-term results of THA with shortened subtrochanteric osteotomy for Crowe IV dysplasia are good, and it is feasible[4–6]. However, the patients' average age in the previous studies was in their 30s–40s (48 years[4]; 46.5[5]; 37.3[6]). This case differs from previous studies in that the patient was an old-old individual with sarcopenia, and the postoperative course and muscle recovery differed depending on the site. At several points, muscle strength and physical and gait performance did not reach the cutoff values

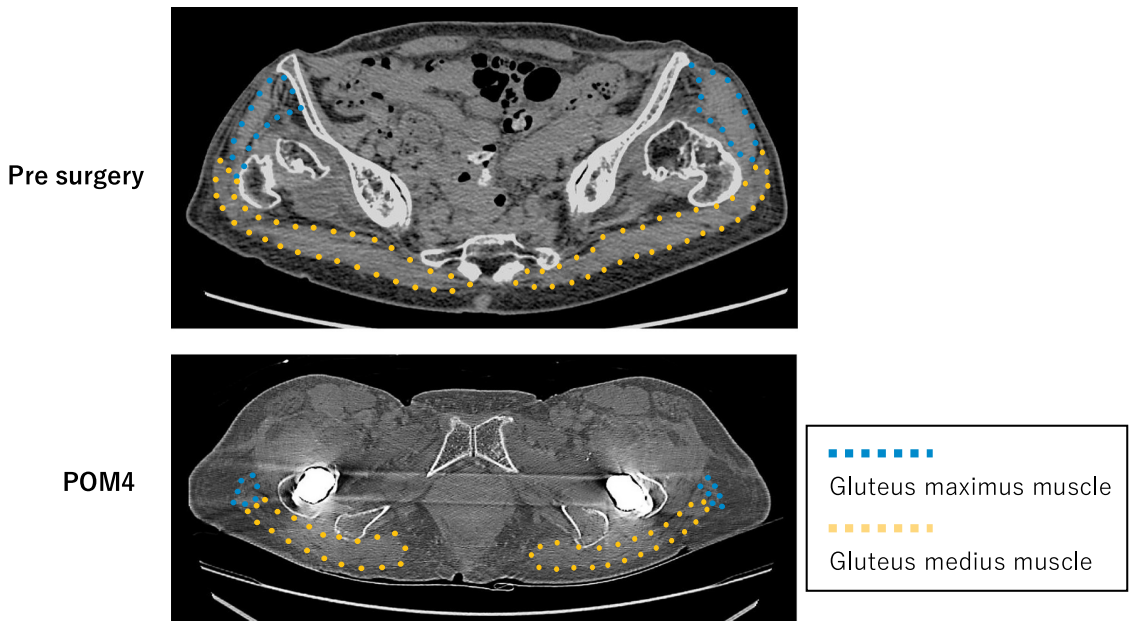

Figure 2. Alteration of muscle mass on a slice at the top tip of the greater trochanter.

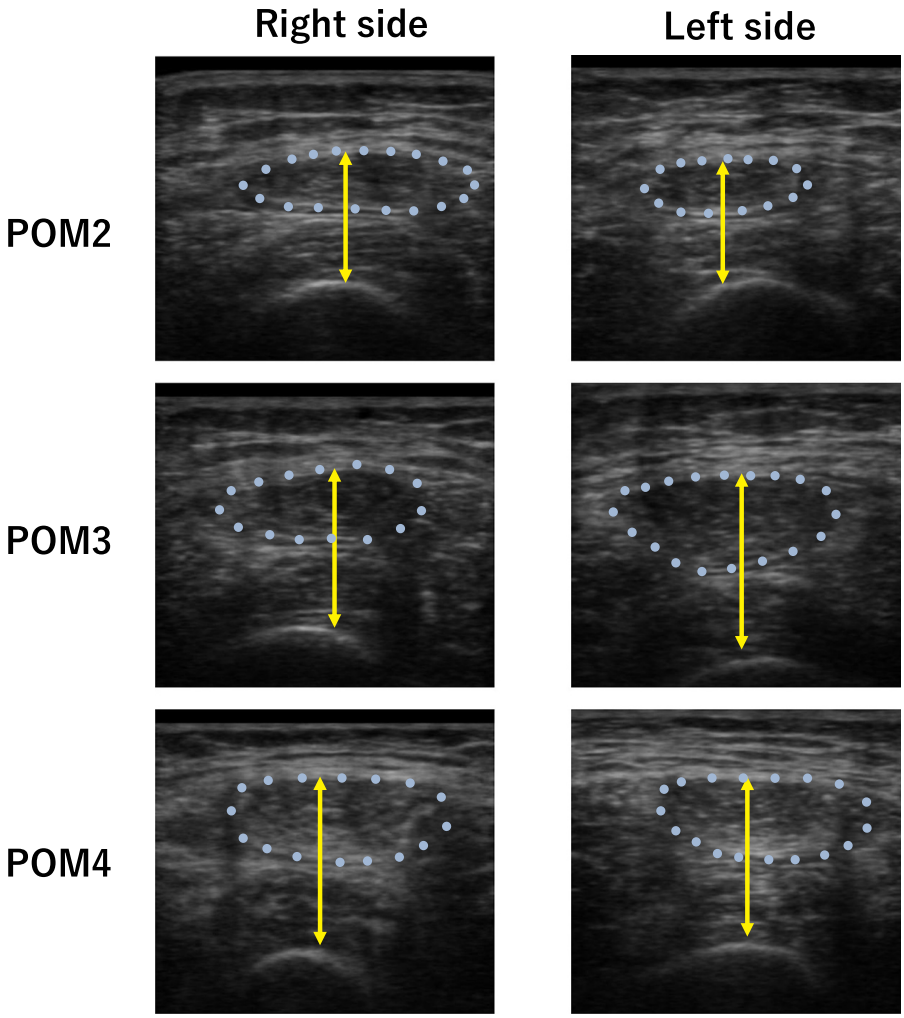

Figure 3. Muscle mass of the quadriceps femoris muscle, muscle thickness, and intramuscular fat of the rectus femoris muscle.

for fall risk. Hence, it seems that there are some areas in which the results of previous studies[4–6] cannot be applied.

Conclusion

The gluteal and knee extensor muscles in THA with shortening subtrochanteric osteotomy for Crowe IV dysplasia in old-old patients differ from those in conventional long-term outcomes; consequently, physical and gait performance at many points did not reach the cutoff values for fall risk.

Table 4

Improvement of muscle mass of knee extensor muscles

	Side	POM2	POM3	POM4
Rectus femoris muscle mass (cm^2)	Right	1.13	1.04	1.36
	Left	0.75	1.17	1.23
Quadriceps femoris muscle thickness (mm)	Right	14.5	16.4	18.6
	Left	13.4	19.3	21.8
Echo intensity (a.u.)	Right	67.8	59.3	58.9
	Left	58.7	52.1	67.4

Ethical approval

In accordance with a policy, case reports are exempt from IRB. Instead, each division is required to upload an informed consent form (in Japanese) to the electronic medical record system.

Consent

A written informed consent was obtained from the case for the data and pictures will be used for academic purposes, such as a conference and a paper.

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Author contributions

Conceptualization: T.I., D.K., and M.W.; funding acquisition: T.I., N.M., and M.W.; data curation: T.I., D.K., K.A., and S.N.; graphic analysis: N.M.; original and revision writing: T.I. and M.W.

Conflicts of interest disclosure

The authors declare no conflict of interest.

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Not applicable.

Declaration of AI and AI-assisted technologies in the writing process

The authors declare no use of AI and AI-assisted technologies.

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