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Assessment of hip muscle deficiency for planning rehabilitation measures in patients with dysplastic coxarthrosis

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A shortcoming of general rehabilitation protocols following hip arthroplasty is that they focus on the overall strengthening of lower-limb muscles without accounting for the specific characteristics of dysplasia. Objective. To develop a tool for determining the level of hip muscle strength deficit and target strength for minimal balance support function in patients with dysplastic coxarthrosis when planning rehabilitation measures. Methods. Twelve patients with dysplastic coxarthrosis were examined one year after endoprosthetics surgery. The average age was (52 ± 4) years. The study used the Marx B scoring system with conversion to normalized coefficients. Results. It was determined that despite an increase in the strength of both the adductor and abductor muscle groups, patients showed increased asymmetry. Although the changes did not reach statistical significance, the clinical effect of the increase in muscle strength can be assessed as moderate, symmetry improved significantly for the adductor muscle group, and remained quite high ($\approx 25\%$) for the abductor muscle group. An algorithm has been developed to determine the muscle strength required to maintain balance for patients who are offered a rehabilitation program. The algorithm is based on normalized strength coefficients — the minimum functional muscle strength required to maintain the basic functions of standing and walking — and the normalized strength coefficient for a given muscle group, determined from the literature. The developed program allows determining the degree of muscle strength deficit responsible for hip function, taking into account the change in offset after endoprosthetics, and makes it possible to develop an individual rehabilitation approach. Conclusions. The implementation of the developed tool facilitates the transition from standardized to personalized approaches in rehabilitation after endoprosthetics, which is key to achieving optimal functional results.

Недолік стандартних методик реабілітації після ендопротезування кульшового суглоба полягає в загальному збільшенні сили м'язів нижніх кінцівок і не враховує особливості дисплазії. Мета. Розробити інструмент визначення рівня дефіциту сили м'язів стегна та цільової сили для мінімальної функції підтримки рівноваги в пацієнтів із диспластичним коксартрозом під час планування реабілітаційних заходів. Методи. Обстежено 12 пацієнтів із диспластичним коксартрозом через рік після операції ендопротезування. Середній вік становив (52 ± 4) роки. У дослідженні використовували схему позиціонування за В. Марксом із переведенням у нормалізовані коефіцієнти. Результати. Визначено, що незважаючи на збільшення сили м'язів як привідної, так і відвідної груп, у пацієнтів спостерігалось збільшення асиметрії. Хоча зміни не досягли статистичної значущості, за клінічним ефектом збільшення сили м'язів можна оцінити як помірне, симетричність помітно покращилась для привідної групи м'язів і залишилась доволі високою ($\approx 25\%$) для відвідної. Розроблено алгоритм визначення необхідної для підтримки рівноваги сили м'язів для пацієнтів, яким пропонується реабілітаційний комплекс заходів. Він ґрунтується на нормалізованих коефіцієнтах сили — мінімальна функціональна сила м'язів, необхідна для підтримки основних функцій стояння та пересування та нормалізованому коефіцієнті, визначеному за даними літератури. Розроблена програма дозволяє встановити ступінь дефіциту сили м'язів, відповідальних за функцію стегна з урахуванням зміни офсету після ендопротезування та дає можливість розробити індивідуальний реабілітаційний підхід. Висновки. Упровадження розробленого інструмента сприяє переходу від стандартизованих до персоналізованих підходів у реабілітації після ендопротезування, що є ключовим для досягнення оптимальних функціональних результатів. Ключові слова. Нормалізована сила м'язів, диспластичний коксартроз, програма реабілітації.

Keywords. Normalized muscle strength, dysplastic coxarthrosis, rehabilitation program

Introduction

Patients with developmental dysplasia of the hip (DDH) and secondary dysplastic coxarthrosis exhibit abnormalities in the anatomical and biomechanical relationships among the acetabulum, femur, and pelvic stabilizing muscles. These abnormalities result in displacement of the hip joint center of rotation, pelvic asymmetry, limb-length discrepancy, and substantial impairment of pelvic girdle muscle function.

These anatomical abnormalities contribute to an imbalance in pelvic girdle muscle function as a result of altered muscle lever arms and long-term adaptation to an abnormal gait pattern. Abnormal acetabular development and altered biomechanics of the pelvic stabilizers are associated with persistent functional weakness of the hip abductors and relative shortening of the adductors, partly due to a flexion-adduction contracture of the hip. These changes impair the effectiveness of horizontal pelvic stabilization and manifest clinically as limping, a positive Trendelenburg sign, a Duchenne gait pattern, reduced muscle endurance, and other functional abnormalities.

Total hip arthroplasty (THA) in patients with dysplastic coxarthrosis often involves additional trauma to the structures of the pelvic girdle, including acetabular reconstruction or deepening, bone grafting, and distalization of the femur, which may require substantial lengthening of the surrounding soft tissues. Such procedures may prolong postoperative rehabilitation and increase the risk of early dislocation, factors that should be taken into account when planning rehabilitation [1]. In patients with dysplastic coxarthrosis accompanied by hip subluxation, femoral distalization may cause considerable stretching of the surrounding soft tissues, including muscles, blood vessels, and nerves, thereby increasing the risk of sciatic nerve neuropathy and potentially impairing muscle function, which may further delay functional recovery [2]. Together with the pathological gait pattern established before surgery and the long-standing imbalance of the pelvic girdle muscles, these factors may adversely affect restoration of normal muscle balance and gait mechanics.

A major limitation of conventional rehabilitation protocols following THA in patients with dysplastic coxarthrosis is their predominant focus on improving overall lower-limb muscle strength and increasing joint range of motion. However, restoration of normal muscle function after hip arthroplasty in this patient population may remain incomplete for several reasons. First, long-standing abnormalities in gait mechanics and the development of maladaptive

compensatory movement patterns require prolonged retraining of motor control and weight-bearing strategies. Second, chronic biomechanical abnormalities of the pelvic girdle may result in structural and functional impairment of its musculature.

Current postoperative rehabilitation protocols for patients with dysplastic coxarthrosis do not sufficiently emphasize restoration of the strength and coordinated function of the muscles responsible for horizontal pelvic stabilization. Consequently, limping, lateral trunk sway during walking, a persistent Trendelenburg sign, and asymmetric loading of the lower limbs may persist for an extended period. Moreover, many rehabilitation programs do not adequately address the pronounced asymmetry in limb loading or the need to retrain abnormal gait mechanics. Assessment of rehabilitation outcomes is often limited to reductions in pain, improvements in joint range of motion, and gains in muscle strength. These measures alone are insufficient for patients with dysplastic coxarthrosis because they do not fully account for long-standing maladaptive motor strategies and the need to restore coordinated, symmetrical gait.

The challenges of achieving full postoperative recovery in patients with dysplastic coxarthrosis are related not only to persistent maladaptive gait patterns but also to potentially irreversible changes in the musculoskeletal and myofascial systems. Long-standing hip contracture leads to structural and functional changes in the muscles, ligaments, and joints not only of the hip but also throughout the lower extremities, which have adapted to a distorted biomechanical environment over an extended period.

Rehabilitation following total hip arthroplasty for dysplastic coxarthrosis should therefore be individualized, biomechanically oriented, and longer in duration, with a particular focus on restoring the function of the pelvic muscles responsible for horizontal stabilization and retraining maladaptive movement strategies. Unfortunately, these aspects are not adequately addressed in standard postoperative rehabilitation protocols.

When developing individualized rehabilitation programs for patients with dysplastic coxarthrosis, it is necessary to consider not only the actual strength of the lower-limb muscles but also the musculoskeletal changes that persist following THA.

Objective: To develop a program for determining the degree of pelvic girdle muscle strength deficit and the minimum strength capacity required to maintain horizontal pelvic stability in patients with dysplastic coxarthrosis when planning rehabilitation interventions.

Materials and Methods

The study was approved by the local bioethics committee (Protocol No. 263, dated 04.05.2026) and conducted in accordance with ICH GCP, the Declaration of Helsinki, the relevant principles of biomedical ethics, and applicable Ukrainian legislation. All participants were informed about the study protocol and conditions and provided written informed consent.

Twelve patients with dysplastic coxarthrosis were examined one year after THA. The mean age was 52 ± 4 years, and women predominated (8 patients, 66.7 %). Hip muscle strength was measured before and after the rehabilitation program to assess muscle imbalance between the operated and contralateral limbs.

Inclusion criteria were an age of 29–75 years and Crowe grade I–III hip dysplasia. All patients had undergone a standard rehabilitation program during the preceding 6–8 months aimed at restoring the strength and endurance of the pelvic girdle and lower-limb muscles.

Muscle strength was measured using a force-measuring device equipped with an SBA-100L strain-gauge load cell.

The study used the positioning protocol described by V. Marks [3], in which hip abduction/adduction was assessed in the supine position, whereas flexion/extension was assessed in the side-lying position, differing from conventional testing positions. The normalized muscle strength values for these positions are presented in Table 1.

Reference coefficients for muscle strength in the supine and side-lying positions were derived from published data [4–9].

The data were analyzed statistically. Normalized muscle strength coefficients are presented as means and standard deviations ($M \pm SD$). Paired measurements were compared using Student's paired t-test, with the t statistic and corresponding p value reported. The paired-samples effect size (d_{rm}) was also calculated. Statistical significance was set at $\alpha = 0.05$. All analyses were performed using R version 4.5.2.

A web-based application was developed using the Shiny framework in R to automatically calculate muscle strength deficits based on normalized strength coefficients.

Results

Our findings indicate that surgical treatment of developmental dysplasia of the hip with total hip arthroplasty is often accompanied by an increase in femoral offset, which results in a longer abductor moment arm. As previously demonstrated by our group [4], an increased offset enhances pelvic stability and reduces the muscular effort required to maintain postural balance. However, changes in femoral offset may also disrupt the symmetry of the muscles responsible for hip flexion, necessitating adaptation of the gait pattern. Accordingly, one of the priorities in the rehabilitation of these patients is to restore the balance of the muscles acting across the contralateral joints. This may require not simply generalized strengthening of the lower extremities, but rather individualized optimization of muscle function and joint mechanics in the more severely affected limb.

To develop an individualized rehabilitation strategy for patients with developmental dysplasia of the hip, we conducted a retrospective study evaluating rehabilitation outcomes in patients with hip osteoarthritis following total hip arthroplasty. Particular attention was paid to the effects of rehabilitation on the strength of the hip adductor and abductor muscle groups.

For this purpose, mean muscle strength and the asymmetry coefficient were calculated before and after a standard rehabilitation program (Table 2).

Despite an increase in the strength of both the adductor and abductor muscle groups, substantial inter-limb asymmetry persisted. Although these changes did not reach statistical significance, the magnitude of the clinical effect associated with the increase in muscle strength was moderate. Symmetry improved noticeably in the adductor group, whereas asymmetry remained relatively pronounced in the abductors, at approximately 25 %.

Table 1

Normalized hip muscle strength values (N/kg) in the supine and side-lying positions

Movement	Muscle	Sex		Minimum functional level
		male	female	
Abduction	<i>Gluteus medius, minimus</i>	$3,45 \pm 0,6$	$2,80 \pm 0,5$	2,1 (Ч), 1,9 (Ж)
Adduction	<i>Adductor magnus/longus</i>	$3,00 \pm 0,5$	$2,55 \pm 0,4$	2,0 (Ч), 1,7 (Ж)
Flexion	<i>Iliopsoas, rectus femoris</i>	$4,45 \pm 0,7$	$3,75 \pm 0,6$	2,9 (Ч), 2,6 (Ж)
Extension	<i>Gluteus maximus, hamstrings</i>	$4,70 \pm 0,8$	$3,95 \pm 0,7$	3,3 (Ч), 2,8 (Ж)

Note. The minimum functional level was defined as approximately 70 % of the mean value.

Analysis of the rehabilitation program revealed a key limitation of the standard approach to patients with developmental dysplasia of the hip following total hip arthroplasty. Because the rehabilitation exercises were prescribed symmetrically for the operated and contralateral limbs, muscle strength increased in both limbs compared with baseline; however, the less affected limb (in this study, the non-operated limb) demonstrated a greater increase in strength. This persistent imbalance may contribute to greater step asymmetry and, consequently, to limping and other gait abnormalities. During training, patients may unconsciously protect the operated limb by reducing its load, limiting its range of motion, and shortening the corresponding step length.

Therefore, rehabilitation should be aimed not only at achieving an adequate level of muscle strength in both limbs, but also at minimizing interlimb asymmetry in muscle function. Muscle strength should be assessed before rehabilitation begins and monitored throughout the rehabilitation process.

To address this issue, we developed an algorithm for determining the level of hip and pelvic-girdle muscle strength required to maintain horizontal pelvic stability in patients with developmental dysplasia of the hip undergoing postoperative rehabilitation. Because the effectiveness of the pelvic-girdle muscles in maintaining horizontal pelvic stability depends on body weight and sex, these parameters are also incorporated into the assessment.

The algorithm is based on normalized strength coefficients, defined as the minimum functional muscle strength required to maintain the basic functions of standing and walking, together with coefficients derived from published reference data.

We also developed an algorithm for assessing hip muscle strength and determining the extent to which muscle strength should be corrected following total hip arthroplasty.

Algorithm for Assessing Isometric Hip Muscle Strength

1. Measurement of muscle strength

During isometric testing, the force generated by the patient in a static position is recorded:

$$F_{\text{meas(kg)}} = \text{dynamometer reading (kg)}, \\ m_{\text{body}} = \text{body mass (kg)}.$$

2. Conversion of force to Newtons

The measured force is converted to Newtons:

$$F_{\text{meas(N)}} = F_{\text{meas(kg)}} \times g,$$

where $g = 9.81 \text{ m/s}^2$.

3. Calculation of the normalized strength coefficient

The normalized strength coefficient is calculated as:

$$K_{\text{norm}} = \frac{F_{\text{meas(kg)}}}{m_{\text{body}}}.$$

This coefficient represents the patient's isometric force relative to body mass and therefore allows muscle strength to be compared across individuals irrespective of body weight.

4. Assessment of deviation from normative values

For each direction of movement, the normalized strength coefficient is compared with the corresponding normative value:

$$P_{\text{norm}} = \frac{K_{\text{meas}}}{K_{\text{norma}}} \times 100 \text{ \%}.$$

5. Criteria for assessing deviation from normal

The degree of deviation from the normative value is classified according to the following criteria:

Percentage of normal	Interpretation
$\geq 85 \text{ \%}$	Normal
70–84 %	Mildly reduced strength
50–69 %	Moderately reduced strength
$< 50 \text{ \%}$	Markedly reduced strength (pathological weakness)
0	Absent

Analysis of adductor and abductor muscle function before and after rehabilitation

Table 2

Muscle group	Статистика	Before rehabilitation	After rehabilitation	Correlation coefficient	Paired t-test, p	Effect size (d_m)
Adductors	Normalized strength coefficient	1.3 ± 0.4	1.5 ± 0.3	$r = 0.536$ $p = 0.215$	$t = -2.300$ $p = 0.061$	0.57
	Asymmetry, %	27.7 ± 26.7	17.0 ± 10.6	$r = -0.070$ $p = 0.881$	$t = 0.961$ $p = 0.374$	0.36
Abductors	Normalized strength coefficient	1.5 ± 0.4	1.8 ± 0.4	$r = 0.589$ $p = 0.164$	$t = -2.302$ $p = 0.061$	0.67
	Asymmetry, %	23.9 ± 14.2	24.8 ± 18.1	$r = 0.784$ $p = 0.037$	$t = -0.218$ $p = 0.835$	0.08

6. Interpretation of the results

A brief assessment is provided for each muscle group, indicating::

$$\text{Висновок} = \begin{cases} \text{Сила в межах норми} & P_{\text{norm}} \geq 85 \% \\ \text{Незначне зниження сили} & 70 \leq P_{\text{norm}} < 85 \% \\ \text{Помірне зниження сили} & 50 \leq P_{\text{norm}} < 70 \% \\ \text{Виразне зниження сили} & P_{\text{norm}} < 50 \%. \end{cases}$$

Based on this algorithm, a software application was developed to generate individualized rehabilitation recommendations. The program takes into account body weight, sex, and the strength of the hip muscle groups. It calculates the patient's actual normalized strength coefficients, compares them with normative values, and determines the minimum target muscle strength required to maintain pelvic stability during standing and walking.

An example of the program interface is shown in Fig. 1.

The proposed algorithm enables quantification of the strength deficit in the muscles responsible for hip function following total hip arthroplasty and provides a basis for developing an individualized rehabilitation strategy.

Discussion

In patients with developmental dysplasia of the hip, muscle strength differs from that observed in patients with idiopathic hip osteoarthritis not only as a consequence of joint degeneration but also because of pre-existing alterations in the biomechanical configuration of the hip, particularly those affecting the abductor muscles. Congenital abnormalities of the hip alter the inclination of the acetabulum, resulting in lateral displacement of the femoral head and a reduction in the abductor moment arm of the gluteus medius. The femoral neck–shaft angle is often less than 135°, which may further reduce the mechanical efficiency of the hip abductors and extensors. Anterior pelvic tilt and anterior displacement of the center of mass may also contribute to increased activation of the hip flexors, particularly the iliopsoas, and reduced contribution of the extensors, including the gluteus maximus [10, 11].

Patients with Crowe type III–IV dysplasia typically present with substantial bone deficiency of the acetabular roof and columns, superior displacement of the femoral head, and shortening of the affected limb. In these cases, a key surgical objective is restoration of the anatomical center of rotation, thereby improving hip biomechanics [12, 13]. However, extensive acetabular reconstruction and bone grafting may require prolonged restrictions on weight bearing and delayed progression to active rehabilita-

tion. This can contribute to the persistence of abnormal movement patterns, including limping, a positive Trendelenburg sign, and impaired hip abductor function resulting from both muscle weakness and long-term adaptation to the preoperative deformity [14, 15].

Current rehabilitation programs following total hip arthroplasty often rely on standardized protocols focused primarily on general strengthening, without adequately accounting for patient-specific factors such as preoperative muscle weakness, interlimb strength asymmetry, hip abductor weakness, and long-term neuromuscular adaptation to skeletal deformity [16]. Consequently, standardized approaches may not fully restore normal hip biomechanics or gait and may be insufficient to prevent persistent limping.

Previous studies have shown that hip abductor strength deficits may persist for 12–24 months after THA, even with progressive rehabilitation, and may remain below the level observed in healthy controls. Reported recovery has been approximately 76–85 %

Оцінка сили м'язів кульшового суглоба

Ввід даних Розрахунок

Маса тіла (кг) 50 Стать Жінка

ПРАВА кінцівка ЛІВА кінцівка

Згинання 10 12

Розгинання 15 18

Відведення 5 3

Приведення 7 4

1) Коефіцієнти сили та асиметрія

Група	Права_сила_кг	K_права	Ліва_сила_кг	K_ліва	Асиметрія
Згинання	10.00	1.96	12.00	2.35	16.7
Розгинання	15.00	2.94	18.00	3.53	16.7
Відведення	5.00	0.98	3.00	0.59	40.0
Приведення	7.00	1.37	4.00	0.78	42.9

2) Дефіцит відносно НОРМИ (%)

Група	Дефіцит_права	Категорія_права	Дефіцит_ліва	Категорія_ліва
Згинання	47.7	значне ↓	37.2	значне ↓
Розгинання	25.5	помірне ↓	10.6	норма
Відведення	65.0	значне ↓	79.0	значне ↓
Приведення	46.1	значне ↓	69.2	значне ↓

3) Дефіцит відносно мінімальної функціональної норми (МФН, %)

Група	Дефіцит_МФН_права	Дефіцит_МФН_ліва
Згинання	24.50	9.40
Відведення	48.40	69.00
Приведення	19.20	53.80

4) Цільова сила (кг) для досягнення МФН

Група	МФН_кг	Цільова_сила_права_кг	Цільова_сила_ліва_кг
Згинання	13.25	13.25	13.25
Відведення	9.68	9.68	9.68
Приведення	8.66	8.66	8.66

Fig. 1. Program interface for determining the required strength of the hip abductor muscles

of the strength of healthy controls for the abductors, compared with approximately 80–85 % for the flexor and extensor muscle groups [17]. Persistent weakness may contribute to compensatory gait abnormalities, including a positive Trendelenburg sign, limping, and lateral trunk lean during walking, as well as reduced quality of life [18, 19].

Based on dynamometric measurements, we developed a dedicated quantitative tool for assessing pelvic-girdle and hip muscle strength deficits. Objective strength assessment using dynamometry makes it possible to identify specific muscle deficits, monitor individual progress over time, and adapt rehabilitation to the patient's specific functional requirements, with particular emphasis on the weakest muscle groups. The proposed tool therefore supports a shift from standardized rehabilitation protocols toward individualized, function-oriented rehabilitation, which may be particularly important for optimizing recovery after THA in patients with developmental dysplasia of the hip.

The developed software application is freely accessible at: <https://m0ygzx-0-0.shinyapps.io/rehabilitation/>

Conclusions

A novel algorithm-based tool was developed for the quantitative assessment of muscle strength deficits and determination of individualized target strength values. The tool facilitates a shift from a standardized to an individualized approach to rehabilitation in patients with developmental dysplasia of the hip following total hip arthroplasty.

The main advantages of this approach include targeted strengthening of weaker muscle groups, reduction of interlimb asymmetry in muscle performance, objective monitoring of rehabilitation through repeated assessment against individualized strength targets, and optimization of limb loading.

Implementation of the proposed tool may contribute to improved functional outcomes, faster recovery of muscle strength, and better quality of life in patients undergoing rehabilitation after total hip arthroplasty.

Conflict of Interest. The authors declare no conflict of interest.

Future Research. Further development of the proposed approach should include clinical validation of the algorithm in larger cohorts of patients with varying degrees of developmental dysplasia of the hip and evaluation of its effectiveness in prospective studies. An important area of research is the establishment of normative and target strength values for individual muscle groups according to sex, age, anthropometric characteristics, severity of dysplasia, preoperative strength deficits, and the extent to which hip biomechanics are restored surgically.

Further refinement of the algorithm should incorporate not only dynamometric measurements but also measures of interlimb load distribution. This would allow the assessment to progress from isolated muscle-strength deficits to a more comprehensive evaluation of functional recovery.

Another promising direction is the development of criteria for automatically adjusting rehabilitation programs according to changes in muscle strength and the extent to which individualized target values are achieved. Such an approach could facilitate the development of individualized recovery trajectories, longitudinal monitoring at different time points after arthroplasty, and early identification of patients at risk of persistent muscle weakness, interlimb loading asymmetry, and abnormal gait patterns.

At present, the application is implemented as a web-based calculator without functionality for storing patient data. Future development could therefore include a comprehensive software platform for rehabilitation planning, longitudinal monitoring, and outcome tracking.

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Author Contributions. O. D. Karpinska — statistical analysis and manuscript preparation; D. O. Yurchenko — study conception and design, data collection and analysis; O. A. Tiazhelov — final approval of the manuscript and critical review.

Generative AI Disclosure. The authors declare the use of generative artificial intelligence during the research process and preparation of the manuscript. In accordance with the GAIDeT (2025) taxonomy, the following tasks were delegated to generative AI tools under full human oversight: literature search and organization, and code optimization.

Generative AI tools used: ChatGPT 5.2 Thinking and R Wizard 5.2.

The authors retain full responsibility for the final manuscript and all of its contents. Generative AI tools are not listed as authors and bear no responsibility for the final results.

Generative AI was also used to assist in searching the literature on normalized muscle-strength data; the relevant literature was subsequently reviewed and analyzed independently by the authors. Generative AI was not used for the interpretation of the study results.

References

1. Liu, T., Wang, S., Huang, G., & Wang, W. (2019). Treatment of Crowe IV developmental dysplasia of the hip with cementless total hip arthroplasty and shortening subtrochanteric osteotomy. *Journal of international medical research*, 47(7), 3223–3233. <https://doi.org/10.1177/0300060519853383>
2. Bianco Prevot, L., Tronconi, L. P., Bolcato, V., Accetta, R., Di Mauro, L., & Basile, G. (2025). Leg length discrepancy after total hip arthroplasty: A review of clinical assessments, imaging diagnostics, and medico-legal implications. *Healthcare*, 13(12), Article 1358. <https://doi.org/10.3390/healthcare13121358> (MDPI)
3. Marks, V. O. (1978). Orthopedic diagnostics. Minsk.
4. Klymovytskyi, R. V., Karpinskaya, E. D., Goncharova, L. D. & Tyazhelov, A. A. (2018). Stabliographic features of standing in patients before and after total hip arthroplasty. *TRAUMA*, 19(3), 24–32
5. Thorborg, K., Petersen, J., Magnusson, S. P., & Hölmich, P. (2010). Clinical assessment of hip strength using a hand-held dynamometer is reliable. *Scandinavian journal of medicine & science in sports*, 20(3), 493–501. <https://doi.org/10.1111/j.1600-0838.2009.00958.x>
6. Mentiplay, B. F., Perraton, L. G., Bower, K. J., Adair, B., Pua, Y.-H., Williams, G. P., McGaw, R., & Clark, R. A. (2015). Assessment of lower limb muscle strength and power using hand-held and fixed dynamometry: A reliability and validity

- study. *PLOS ONE*, 10(10), e0140822. <https://doi.org/10.1371/journal.pone.0140822>
7. Bohannon, R. W. (1997). Reference values for extremity muscle strength obtained by hand-held dynamometry from adults aged 20 to 79 years. *Archives of Physical medicine and rehabilitation*, 78(1), 26–32. [https://doi.org/10.1016/S0003-9993\(97\)90005-8](https://doi.org/10.1016/S0003-9993(97)90005-8)
 8. Aerts, F., Sheets, H., Anderson, C., Bussie, N., Hoskins, R., Maninga, A., & Novak, E. (2025). Reliability and agreement of hand-held dynamometry using three standard rater test positions. *International journal of sports physical therapy*, 20(2), 243–252. <https://doi.org/10.26603/001c.128286> (ijspt.scholasticahq.com)
 9. McKay, M. J., Baldwin, J. N., Ferreira, P., Simic, M., Vanicek, N., & Burns, J. (2017). Normative reference values for strength and flexibility of 1,000 children and adults. *Neurology*, 88(1), 36–43. <https://doi.org/10.1212/WNL.0000000000003466> (PubMed)
 10. Landi, F., Calvani, R., Martone, A. M., Salini, S., Zazzara, M. B., Candeloro, M., Coelho-Júnior, H. J., Tosato, M., Picca, A., & Marzetti, E. (2020). Normative values of muscle strength across ages in a “real world” population: Results from the longevity check-up 7+ project. *Journal of cachexia, sarcopenia and muscle*, 11, 1562–1569. <https://doi.org/10.1002/jcsm.12610>
 11. Karpinskaya, O. D., Karpinsky, M. Y., Tyazhelov, O. A., Klymovytsky, V. G., Goncharova, L. D., & Yurchenko, D. A. (2023). Study of changes in the balance of the pelvic girdle muscles in patients with dysplastic coxarthrosis after arthroplasty. *TRAUMA*, 24(2), 36–45. <https://doi.org/10.22141/1608-1706.2.24.2023.943> (trauma-journal.com)
 12. Tyazhelov, A. A., Karpinsky, M. Yu., Karpinska, O. D., Honcharova, L. D., Klymovytskyi, R. V., & Fishchenko, V. A. (2017). Clinical and biomechanical substantiation and construction of a model of the muscles that ensure horizontal balance of the pelvis. *Trauma*, 18(5), 13–18. <https://doi.org/10.22141/1608-1706.5.18.2017.114115>
 13. Shen, J., Sun, J., Ma, H., Du, Y., Li, T., & Zhou, Y. (2020). High hip center technique in total hip arthroplasty for Crowe type II–III developmental dysplasia: Results of midterm follow-up. *Orthopaedic surgery*, 12(4), 1245–1252. <https://doi.org/10.1111/os.12756>
 14. Zhang, B., Li, M., Li, H., Zhou, Y., Zhang, H., Kong, X., & Chai, W. (2025). The optimal centre of rotation for total hip arthroplasty in patients with unilateral Hartofilakidis type B developmental dysplasia of the hip: A cohort study with a mean follow-up of eight years. *The bone & joint journal*, 107-B(11), 1171–1181. <https://doi.org/10.1302/0301-620X.107B11.BJJ-2025-0473.R1>
 15. Qian, H., Wang, X., Wang, P., Zhang, G., Dang, X., Wang, K., & Liu, R. (2023). Total hip arthroplasty in patients with Crowe III/IV developmental dysplasia of the hip: Acetabular morphology and reconstruction techniques. *Orthopaedic surgery*, 15(6), 1468–1476. <https://doi.org/10.1111/os.13733>
 16. Faldini, C., Tassinari, L., Pederiva, D., Rossomando, V., Brunello, M., Pilla, F., Geraci, G., Traina, F., & Di Martino, A. (2024). Direct anterior approach in total hip arthroplasty for severe Crowe IV dysplasia: Retrospective clinical and radiological study. *Medicina*, 60(1), Article 114. <https://doi.org/10.3390/medicina60010114>
 17. Ismailidis, P., Kvarda, P., Vach, W., Cadosch, D., Appenzeller-Herzog, C., & Mündermann, A. (2021). Abductor muscle strength deficit in patients after total hip arthroplasty: A systematic review and meta-analysis. *The journal of arthroplasty*, 36(8), 3015–3027. <https://doi.org/10.1016/j.arth.2021.03.042>
 18. Tanaka, H., Yamada, N., Kurishima, H., Mori, Y., & Aizawa, T. (2022). Association between hip center position and isokinetic hip muscle performance after anterolateral muscle-sparing total hip arthroplasty. *Medicina*, 58(4), Article 538. <https://doi.org/10.3390/medicina58040538>
 19. Hu, X., Zheng, N., Hsu, W.-C., Zhang, J., Li, H., Chen, Y., Dai, K., & Tsai, T.-Y. (2020). Adverse effects of total hip arthroplasty on the hip abductor and adductor muscle lengths and moment arms during gait. *Journal of orthopaedic surgery and research*, 15(1), Article 315. <https://doi.org/10.1186/s13018-020-01832-1>

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ASSESSMENT OF HIP MUSCLE DEFICIENCY FOR PLANNING REHABILITATION MEASURES IN PATIENTS WITH DYSPLASTIC COXARTHROSIS

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