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Research article

The muscle strength of the hip joint can be used as a criterion of quality rehabilitation patients after total hip arthroplasty

Marjan Mihajlov [1,2], Marian Dragomir [1], Alexandra Bausic [3], Kristo Xhardo [4], Ilie Onu [5,6,8,*], Laurențiu Gabriel Talaghir [7,8,†], Daniel Mădălin Coja [7,8,†], Daniel Andrei Iordan [7,8,*], Carmina Liana Musat [9,10], Bogdan Voicu [11]

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1 Faculty of Physical Education and Sports, University of Craiova, 200207 Craiova;
2 Bucharest Clinical Emergency Hospital, 014461 București;
3 "Carol Davila" University of Medicine and Pharmacy, 020021 Bucharest, Romania;
4 Faculty of Physical Education and Sports, National University of Physical Education and Sports, 060057 Bucharest, Romania;
5 Department of Biomedical Sciences, Faculty of Medical Bioengineering, University of Medicine and Pharmacy "Grigore T. Popa" Iasi, 700454 Iasi, Romania;
6 Department of Physiotherapy, Elipetro Med Clinic, 610119 Piatra Neamt, Romania;
7 Department of Individual Sports and Kinetotherapy, Faculty of Physical Education and Sport, "Dunarea de Jos" University of Galati, 800008 Galati, Romania;
8 Center of Physical Therapy and Rehabilitation, "Dunărea de Jos" University of Galati, 800008 Galati;
9 Department of Morphological and Functional Sciences, Faculty of Medicine and Pharmacy, 'Dunarea de Jos' University, 800008 Galati, Romania;
10 'Sf. Apostol Andrei' Clinical Emergency County Hospital, 800578 Galati, Romania;
11 OKF Medical Center, Târgu Mureș, Romania

* Correspondence: Daniel Andrei Iordan, Ilie Onu, E-mail: daniel.iordan@ugal.ro, ilie.onu@umfiasi.ro

Abstract: Background: The primary aim of this study is to evaluate the efficacy of rehabilitation following total hip arthroplasty (THA) through the assessment of hip joint mobility parameters, namely abduction, extension, and flexion, at 2, 4, and 6 weeks post-surgery. These evaluations coincide with the implementation of rehabilitation exercises recommended by the physiotherapist. The study intends to analyze the progression of hip mobility during these specific time intervals in conjunction with the prescribed rehabilitation program. By examining the relationship between the performed exercises and the observed improvements in hip mobility, the research aims to provide valuable insights into the effectiveness of the rehabilitation protocol in facilitating post-THA rehabilitation. **Material and method**: The evaluation of hip joint mobility encompassed measurements of abduction, extension, and flexion utilizing a "Active Force 2" digital dynamometer. In tandem, the functional assessment of patients' health status was conducted through the utilization of the WOMAC index (Western Ontario and McMaster Universities Osteoarthritis Index). **Results**: The experimental data acquired in the measurement joint mobility during abduction, extension and flexion at 2, 4 and 6 weeks of exercises performed after THA are presented. Pain: mean score decreased from 3.08 to 1.18 (38.31% improvement); physical difficulties: mean score decreased from 3.10 to 1.01 (32.25% improvement) and joint stiffness: mean score decreased from 3.41 to 0.65 (19.06% improvement). These findings highlight the effectiveness of the recovery exercises in reducing pain, improving physical function, and decreasing joint stiffness post-THA. **Conclusions**: Our research emphasizes the essential contri-bution of physiotherapists to achieving positive outcomes for patients post-THA surgery. Through a personalized physiotherapy regimen administered during follow-up appointments, patients undergoing THA exhibited notable functional improvements. The study's results high-light the efficacy of this approach in alleviating discomfort, expediting recovery, and enhancing patients' overall quality of life, enabling a smoother transition back to normal daily activities.

Keywords: total hip arthroplasty, physiotherapy, rehabilitation, hip joint mobility, muscle strenght

1. Introduction

The hip joint, situated at the junction of the thigh and pelvis, resembles a ball and socket configuration. Its remarkable stability arises from the snug fit of the femur's head within the acetabulum. Smooth cartilage coats both the femoral head and the acetabulum, facilitating frictionless movement between the bones. Nonetheless, over time, this cartilage undergoes natural degradation, leading to a roughened surface that affects the joint's ability to bear weight.

These degenerative processes that appear over time lead to the condition known as osteoarthritis (OA). Hip fracture is the most serious complication of joint OA. There are many causes of OA: sagittal joint misalignment, overweight, obesity, immobilization, or excessive sports activity. In the last stage of OA, a total hip arthroplasty (THA) is necessary.

Rehabilitation from THA surgery is a gradual process that requires adherence to specific guidelines to ensure safety and optimal healing. The primary focus of rehabilitation is to restore articular mobility and muscle strength in the stabilizing muscles of the hip. Rehabilitation commences immediately after THA surgery and continues throughout the hospitalization period. The physiotherapist conducts a comprehensive assessment of the patient's mobility, flexibility, and strength to identify any underlying deficits contributing to increased stress on the affected joint. Patients receive counseling on which activities can be safely continued and which should be avoided to prevent complications.

The physiotherapist designs an exercise program tailored to the individual's needs, aiming to reduce joint stress. Typically, this involves a combination of strengthening and stretching exercises targeting the muscles around the hip and knee, as well as core strengthening exercises. Furthermore, human gait analysis and ongoing monitoring following THA, coupled with rehabilitation exercises prescribed by physiotherapists, offer valuable insights into the stage of medical recovery.

Krastanova et al. (2017) implemented a postoperative rehabilitation protocol following THA surgery. This comprehensive program included a combination of isometric exercises and targeted isotonic exercises designed to preserve and enhance the range of motion of both the hip and knee joints, as well as to strengthen the gluteal muscles. [1]. Colibazzi et al. (2020) highlight the importance of organizing scientific evidence systematically to identify appropriate methods for functional rehabilitation in patients undergoing THA [2]. Hence, the full potential of resistance exercise remains uncertain, prompting the need for further investigations to clarify its impact on the functional recovery of patients undergoing THA.

In a study by Umpierres et al. (2014), it was found that performing three sets of 12 repetitions led to improvements in muscle strength of the hip abductors, adductors, and rotators, as well as the knee flexors and extensors. Protocols involving 2 to 3 sets of 8 to 12 repetitions are considered to be more effective for enhancing muscle strength in both healthy individuals and patients undergoing THA [3].

Di Monaco and Castiglioni (2013) in a systematic review evaluated the effectiveness of exercise therapy post-THA, focusing on type and timing. Eleven papers reporting nine randomized controlled trials (RCTs) were analyzed, revealing mixed trial quality and varied exercise interventions. While some early postoperative benefits were associated with ergometer cycling and maximal strength training, evidence for specific exercise types remains inconclusive, highlighting the need for further research to define optimal exercise protocols for THA rehabilitation [4].

Rampazo-Lacativa and D'Elboux (2015) assess the feasibility of ergometer cycling-associated conventional exercises on functional outcomes and quality of life in older patients post-THA in an RCT. Patients (≥60 years) will be randomly assigned to either a group performing both cycling and conventional exercises or a group performing only conventional exercises, with assessments at baseline, post-intervention, and 6-month follow-up. The trial aims to provide evidence on the efficacy of exercise therapy for older THA patients, with potential implications for postoperative rehabilitation protocols [5].

2. Materials and Methods

To ascertain the most effective approaches for administering physiotherapy intervention in THA, both structural organization and content are crucial considerations. Physical activity serves a therapeutic purpose in THA rehabilitation, impacting both physical and psychological aspects through various exercise types and delivery methods. The variables and tools outlined in Table 1 will be employed to explore and analyze these factors comprehensively.

Table 1. Variables and instruments that will be measured:

Variables	Measuring instrument	Measurements	Variable category
Range of motion of the operated hip joint	Dynamometer	Initial/ Final	Dependent
Passive movement	Dynamometer	Initia/l Final	Dependent
Muscle strength of the hip abductors and flexors in the operated limb	Dynamometer	Initial /Final	Dependent

The instruments described in the instruments section will be used to evaluate all individuals both on the day of release (initial assessment) and after the recovery program (final assessment).

Depending on the personal option, discharged patients will be included in:

- The experimental postoperative recovery group using the author's technique;
- Different postoperative recovery regimens are used by the control group.

The experimental group performed 23-25 physical therapy sessions in total during 12 weeks. A session lasting 45-60 minutes incorporating exercises to enhance hip stabilizer muscle strength, improve overall muscle strength, increase hip mobility, incorporate stretching exercises, focus on balance training, and include stair climbing/descending exercises were implemented. In the second week following surgery, the postoperative rehabilitation exercise starts.

The study included individuals who had undergone total hip replacement surgery, were aged 35-50 years, and opted to participate voluntarily. Excluded were those facing major postoperative complications such as hemarthrosis, hip joint fracture, infection, or diagnosed mental health disorders.

Manual muscle testing (MMT) has been used several times to evaluate muscle strength [6]. However, MMT for strength assessment has been criticized for its subjectivity in quantifying muscle force analysis [7,8].

Hand-held dynamometers (HHDs) present an alternative to manual muscle testing (MMT) for objectively tracking patients' strength improvement over time. They provide dependable measurements of muscle force and function. In this study, the ActivForce 2 digital dynamometer, a new HHD, was employed as a tool to monitor muscle deflection. It allows for the assessment of peak force, average force, range of force, range of motion (both active-AROM and passive-PROM), and the comparison of strength and range of motion between the right and left sides [9].

The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) used a set of standardized questionnaires to evaluate the condition of patients with osteoarthritis of the knee and hip including physical function, pain, and stiffness of the joints. The test questions are scored on a scale of 0-4. which correspond to: none (0), mild (1), moderate (2), severe (3), and extreme (4) [10].

The patients were tested with the HHD while standing upright after 2, 4, and 6 weeks after THA rehabilitation exercises. To stabilize that side, the hip and limb exactly opposite the one being tested were placed up against a wall. The dynamometer was positioned on

the lateral epicondyle of the patient's limb, which was abducted 10°. The examiner was braced to help them resist the patient's forceful abduction while maintaining control of the dynamometer.

Patients were recruited as they were discharged after surgery at Euroclinic Hospital. The study was approved by the Ethics Commission of the Department of Physiotherapy, Elipetro Med Clinic, Piatra Neamt, Romania, with no. 33 from 10 October 2021, and was conducted by the principles set out in the Declaration of Helsinki. All patients have signed a consent form, and they agreed with their participation in the study.

3. Results

Experimental data acquisition of joint mobility via muscle strength measurement in abduction, extension, and flexion during a period of 2, 4, and 6 weeks after THA recovery exercises are presented below.

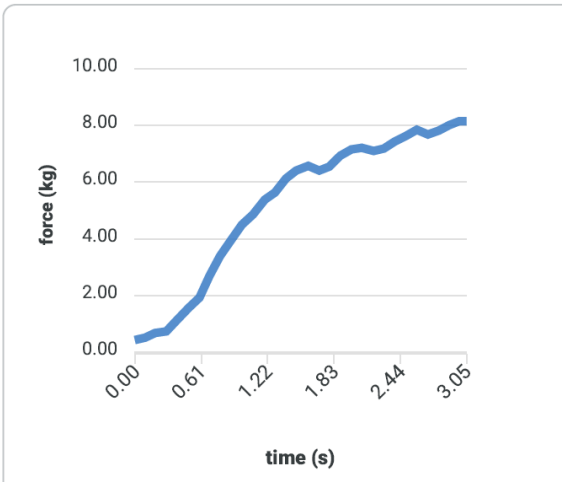

Figure 1 Hip abduction standing after 2 weeks

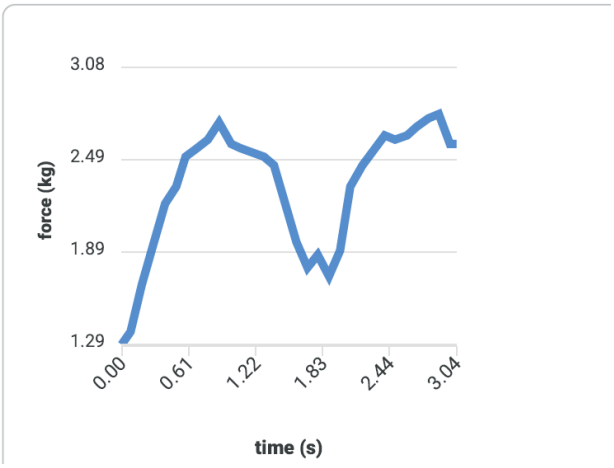

Figure 2 Hip extension standing after 2 weeks

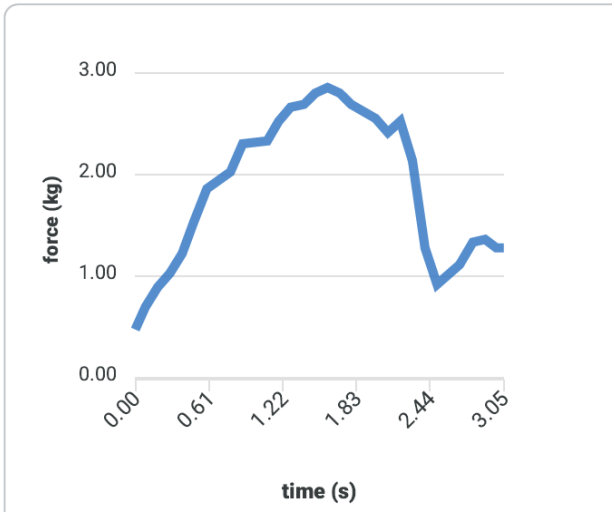

Figure 3 Hip flexion standing after 2 weeks

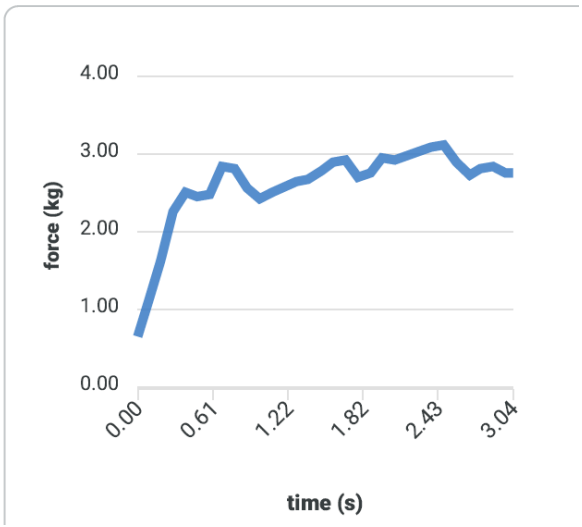

Figure 4 Hip abduction standing after 4 weeks

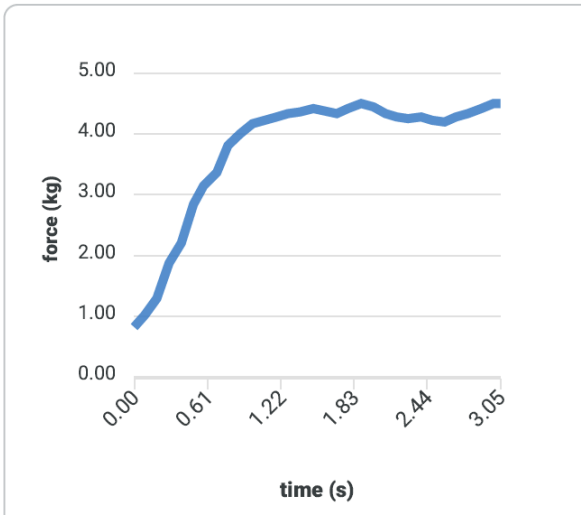

Figure 5 Hip extension standing after 4 weeks

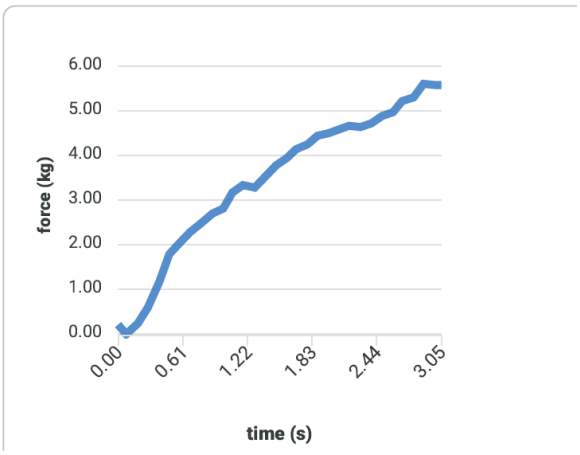

Figure 6 Hip flexion standing after 4 weeks

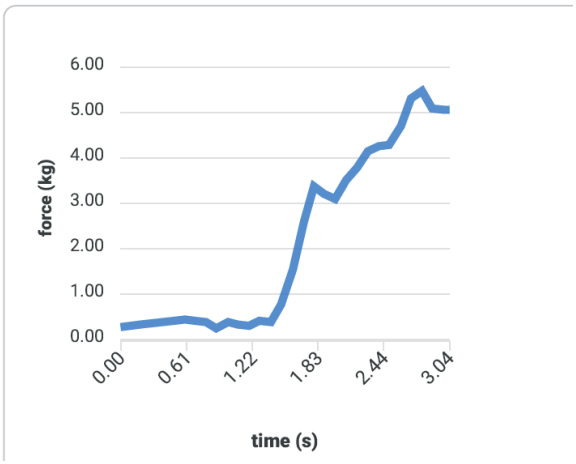

Figure 7 Hip abduction standing after 6 weeks

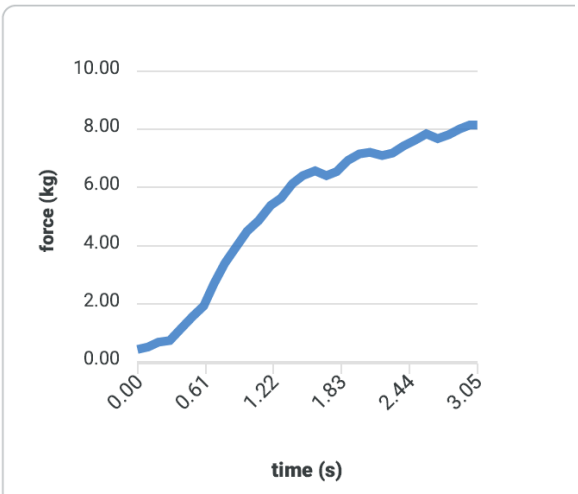

Figure 8 Hip extension standing after 6 weeks

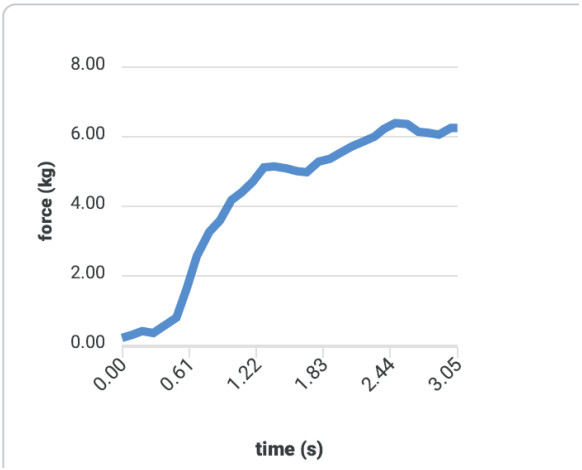

Figure 9 Hip flexion standing after 6 weeks

To verify the results of the experimental data acquisition of deflection in abduction, extension, and flexion during a period of 2, 4, and 6 weeks after THA recovery exercises, a WOMAC test has been used.

The results of WOMAC tests are shown in the table below.

Table 1. The results of WOMAC tests

WOMAC condition of patients	Before surgery (THA)		After 6 weeks of recovery exercises		Percentage
	Mean	Stdandar dDeviation	Mean	Stdandar dDeviation	Mean difference %
Pain	3.08	0.605	1.18	0.504	38.31
Physical difficulties	3.10	0.575	1.01	0.704	32.25
Stiffness joint	3.41	0.878	0.65	0.601	19.06

4. Discussion

Based on the analysis of Figures 1-9 and Table 1, the following conclusions can be drawn:

- A muscle strength increase of 2.24 is observed in abduction after 6 weeks compared to the initial week.
- There is a muscle strength increase of 5.38 in extension after 6 weeks when compared to the first week.
- A muscle strength increase of 4.38 is noted in AROM flexion after 6 weeks compared to the initial week.

The mean percentage difference after 6 weeks of recovery exercises of the patients are 38.31 % for pain, 32.25 % for physical difficulties, and 19.06 % for stiffness joint.

The measured muscle strength can be utilized as a criterion for the effectiveness of rehabilitation following THA. Increased muscle strength values translate into improved mobility, decreased pain, and faster walking.

The reported results in the study are congruent with the ones reported in very recent studies: Karagiannopoulos et al. (2022)[9]; Arias-de la Torre et al. (2018) [11]; Chaudhryet al. (2022)[12]; Contreras-Diaz et al. (2022)[13]; Huang et al. (2020)[14]; Madara et al. (2019)[15]; Salas-Gómez et al. (2022)[16]; Tanghe et al. (2022)[17].

One aspect that can be mentioned is that patients who were sports enthusiasts in their youth with normal physical activity recorded shorter recovery times, and the willingness to correctly execute the exercise program and complete the therapeutic protocol was higher than in sedentary patients. Although recovery times were somewhat shorter in former athletes, Tenforde et al. showed a higher prevalence of THA in amateur athletes than in the general population, suggesting that football may contribute to a higher risk of THA at younger ages [18]. Gurau et al. demonstrated that the prevalence of lower limb injuries in amateur footballers is much higher than in the general population [19,20].

THA is a common procedure used to address hip joint pain and dysfunction, which can be particularly relevant for sports players and coaches who rely heavily on lower body mobility and strength for their sport. However, THA can also introduce challenges during the recovery process, including potential disruptions to movement patterns, proprioception, and neuromuscular control. This is where neurofeedback therapy could play a significant role.

Neurofeedback, which involves real-time monitoring and regulation of brain activity, has been utilized in various rehabilitation settings to enhance motor learning, coordination, and performance. For sports players and coaches undergoing THA, neurofeedback could help optimize their rehabilitation by targeting specific areas of the brain involved in motor control and proprioception. By incorporating neurofeedback into the rehabilitation process, tennis players and coaches undergoing THA may experience improvements in movement quality, joint stability, and overall functional outcomes. This, in turn, could facilitate a smoother return to the court and potentially reduce the risk of re-injury or compensation-related issues [21,22].

Moreover, coaches could play a pivotal role in supporting sports players through the rehabilitation process, providing guidance, motivation, and feedback to ensure adherence to the neurofeedback therapy protocols and overall rehabilitation program [23].

Caution should be exercised in interpreting the obtained results due to several limitations. Theoretical constraints include the absence of prior research conducted in Romania on this subject, limiting the ability to compare concepts and findings. Methodological limitations stem from the experimental use of the Digital Force 2 device, which may have led to patients' lack of familiarity with it. Moreover, the intervention therapist doubling as the researcher responsible for data collection introduces potential bias. Additionally, the relatively small sample size may hinder a reliable and direct assessment of the recovery program's effects. Despite these limitations, it can be stated that the objectives of this preliminary study were fulfilled.

5. Conclusions

Our research underscores the pivotal role of physiotherapists in achieving favorable outcomes for patients undergoing THA surgery. Patients who received THA demonstrated significant functional improvement due to the structured physiotherapy regimen administered during follow-up visits.

Pain: The mean pain score decreased from 3.08 to 1.18, indicating a 38.31% improvement.

Physical difficulties: The mean score decreased from 3.10 to 1.01, reflecting a 32.25% improvement.

Joint stiffness: The mean score decreased from 3.41 to 0.65, showing a 19.06% improvement.

These results underscore the efficacy of the prescribed rehabilitation exercises in alleviating pain, enhancing physical function, and reducing joint stiffness post-THA. The findings highlight the therapeutic benefits of this approach in minimizing discomfort,

facilitating patient recovery, and enhancing overall quality of life, thereby enabling a return to normal activities.

Institutional Review Board Statement: The study was approved by the Ethics Commission of the Department of Physiotherapy, Elipetro Med Clinic, Piatra Neamt, Romania, with no. 33 from 10 octomber 2021.

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Informed Consent Statement: The study was conducted by the principles set out in the Declaration of Helsinki. All patients were properly informed, agreed with their participation in the study, and signed a consent form.

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