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Research Article

Chest Expander Spring a Low Cost Home Physiotherapy-Based Exercise Rehabilitation after Total Hip Arthroplasty

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Abstract

Background: The demand for total hip arthroplasty (THA) is rising. Postoperative exercise rehabilitation helps patients recover normal joint functions by strengthening the muscles surrounding the replaced hip joint. In the face of rapidly increasing health care costs, ensuring widespread, cost-effective rehabilitation is a priority. However, the high cost of professionally supervised exercise rehabilitation programs limits access to program participation and,

thus, to optimal recover of normal joint functions. Therefore, the development of an effective home-based, self-monitored exercise rehabilitation program is critical to promote the optimal recovery of THR patients.

Purpose: The aim of this study was to assess the feasibility, evaluate the effectiveness of a specific Progressive Resistance Exercise program for improving hip muscles strength, resorting hip joint mobility and address the functional needs of the patient treated with primary total hip arthroplasty. Additionally; spreading the idea of a low-cost post-operative rehabilitation program using chest expander spring.

Study Design: Prospective case series study.

Patients and Methods: This was a prospective single-center clinical study with a 12-week intervention program carried out in an outpatient clinic and in home based. 120 patients (84 males) had been enrolled in this study to which primary total hip arthroplasty had been done. Patients were evaluated preoperatively, at baseline, 2 weeks postoperative, one week following last visit of follow-up and at 6 months postoperatively. Clinical outcome measures involved: Harris Hip Score (HHS), Oxford Hip Score (OHS), WOMAC activity score, range of hip movements (ROM), Timed Get Up and GO Test and 6 Minutes walking test.

Results: The study included 120 patients (84 males). The mean age 65.3 years (range = 53-76 years). Results of clinical functional outcomes showed a progressive improvement at follow ups regarding : Harris Hip Score, Oxford Hip Score, WOMAC activity score (related to pain, stiffness and physical functions), range of hip motions, time effect for Get up-and-go test and 6-minute walking distance test. The improvement is more achieved in last follow up visit and after 6 months postoperative.

Conclusions: The study demonstrates that this novel low-cost solution holds promise in rehabilitation after THA, ensuring better clinical outcomes than conventional rehabilitation while reducing dependence on human resources. Considering the low cost and convenience of a home-based resistance training program, health professionals should consider this and similar exercise programs when providing guidance to THR patients particularly in low-income countries.

Keywords: Total hip arthroplasty; Home-based rehabilitation; Physiotherapy protocol; Chest expander; Hip functional outcomes

1. Introduction

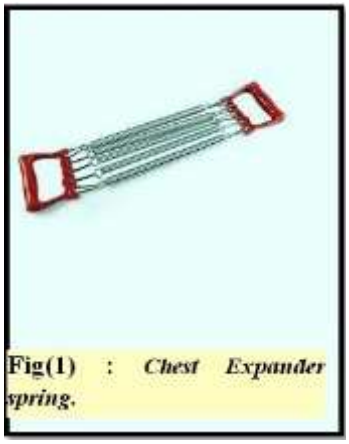
Total hip Arthroplasty (THA) is considered as one of the most common elective, cost-effective and successful operations for relieving hip pain and improving physical functions caused by arthritis [1]. Also, a dramatic annual increase in the number of joint replacements over the last few decades throughout the world [2]. Owing to persistence of the underlying pre-operative pathology, patients may present with muscle atrophy and loss of strength, particularly in the glutei and quadriceps muscles. Consequently the elderly patients are less independent [3]. It makes sense that surgical intervention will correct the joint problems(either mechanical or anatomical) but associated muscle power impairment and functional limitations that was present before

surgery, will remain (even up to a year following surgery) and require post-operative rehabilitation. Traditionally, physiotherapy has been a routine component of patient rehabilitation following hip replacement surgery [4]. So it is valid to consider how effective post-discharge Rehabilitation protocols after total hip replacement vary widely in both the specific exercises used and the timeframes for their delivery [4, 5].

Research has shown hip abductor weakness after surgery is a major risk associated with joint instability and prosthetic loosening [6]. So; post-operative rehabilitation program is mandatory to restore hip joint mobility, gain muscle strength and flexibility and share in reducing pain. In low income countries with unavailability of good rehabilitation centers there is an increased demand for a low cost rehabilitation protocol, easy to do, cost effective and easy to understand to the patient and relatives without highly occupied palace for rehabilitation to achieve satisfactory outcome after hip Arthroplasty.

2. Patient and Method

Chest Expander Spring is simple exercise equipment consisting of a pair of handles connected by springs (either 4 or 5 springs) that provide resistance (Figure 1).



Fig(1) : *Chest Expander spring.*

Traditionally, it targets the chest muscles but it can also be used to exercise the legs and back muscles as well. In this study the expander used to restore the hip muscles strength through Resistive hip muscle exercise as self-dependent patient rehabilitation. The 4 muscles group of the hip (Flexors, Extensors, Abductors and Adductors group of muscles) are trained and strengthened by adding one spring each time the muscles trained. Many strengthening exercises can be accomplished with the patient standing, sitting on a chair or lying on an exercise mat, allowing the patient to make the workout as strenuous or as relaxing as he/she needs. One end (hand gripper) is fixed to the ground while the other end is free to be prepared to adapt the foot of the patient. It is used as an outdoor or indoor Exercise Fitness Strength and Training Adjustable Resistance tool. The program is so simple as Exercise can be done while patient watching TV, at the office, traveling, or doing outdoor activities! It is a a versatile device allows the patient to strengthen almost every muscle part, and at the same time is light and takes up

little space To increase the resistance as the muscles are developed, the user can simply add additional springs Many new types of expanders have appeared on the market. The most universal are those made of rubber. They can extend to a greater width, and at the same time have cables with different degrees of tension (Figure 2).

Fig.(2) : *Rubber type of Expander*

2.1 Flexor group

The patient is standing with his/her back against the seat to which the Chest Expander Spring is attached. Patient's foot of operated limb anchored to the free hand gripper of the Chest Expander Spring. The patient pulls the operated limb forward against resistance of the spring keeping the knee straight then he/she allows his/her limb to return to its previous position (Figures 3a, 3b).

Fig.(3a): *The patient(X) pulls the operated limb forward against resistance of the spring.* ***Training Hip flexors***

Fig.(3b): *Another patient (2)* ***training hip flexors***

2.2 Extensor group

The patient is standing and faces forward toward the seat to which the Chest Expander Spring is attached.

Patient's feet are slightly apart and the foot of operated limb anchored to the free hand gripper of the spring. The patient pulls his/her operated limb straight backward against resistance of the spring with the knee straight then allowing the operated limb to return to its previous position (Figures 4a, 4b).

Fig. (4a): *The patient (x) pulls his/her operated limb straight backward against resistance of the spring .* **Training Hip Extensors.**

Fig. (4b): *Another patient(z)* **training hip extensors**

2.3 Adductor group

The patient stands with his/her operated limb abducted. Patient's ankle of operated limb anchored to the handgrip end of the spring. Patient Keeps his/her operated limb straight, drawing it inward against resistance of the spring until it touches the other limb or moving the operated limb toward the center of his/her body Pausing in this position for a second before slowly returning to the starting position and repeat the exercise. Patient warranted never cross the midline or the other feet (Figures 5a, 5b, 5c, 5d).

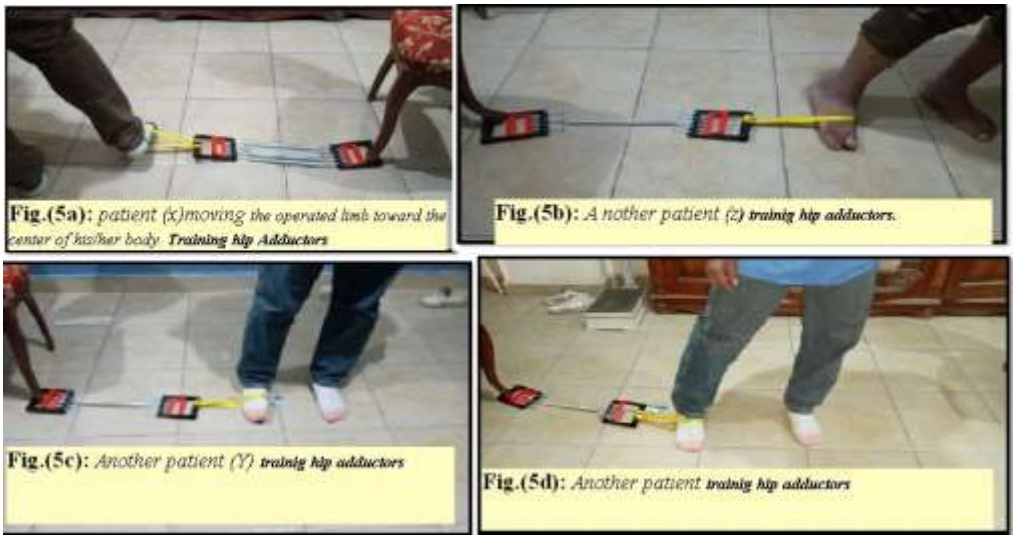


Fig.(5a): *patient (x)moving the operated limb toward the center of his/her body* **Training hip Adductors**

Fig.(5b): *A nother patient (z)* **trainig hip adductors.**

Fig.(5c): *Another patient (Y)* **trainig hip adductors**

Fig.(5d): *Another patient* **trainig hip adductors**

2.4 Abductor group

Patient stands sideway from the seat to which the Chest Expander Spring is attached. He/she extends his/her operated limb out to the side against resistance of the spring then allows his/ her limb to return to its previous position (Figures 6a, 6b, 6c). Each exercise is done for 10-15 minutes twice daily then gradually building up to 20 to30 minutes 3 or 4 times a day. The

whole exercises started by single spring within the expander then increase by one more every week of exercises. Total time of the program 5 weeks (equal 5 springs within the chest expander).

3. Study Population

120 patients (84 males and 36 females) were enrolled in this prospective observational clinical study. All were complaining of varying complaint of osteoarthritis of hip joint and primary total hip arthroplasty had been done. The mean age 49.8 years (range, 38 to 65 years). All the patients completed the study and non was lost to follow-up. The study was initiated after receiving approval from the institutional ethics committee for research in accordance with the ethical standards laid down in the 1964 declaration of Helsinki and its later amendments. Also, a written consent had been obtained from all patients for participating in the study. Exclusion criteria involved patients below 20 years age, patients with revision hip arthroplasty, Arthroplasty due to fracture or causes other than osteoarthritis, patients with neuromuscular disorders that affect cognition or movement ability, any condition that resulted in complete lack of sensation in the lower extremity or patients had any cardiovascular or pulmonary condition that would affect their ability to practice the physiotherapy program. Also patients with complicated prosthesis (as loosening, infection and implant failure were excluded.

4. Measurements

Patients completed a pre-operative assessment two weeks before THA by two of the authors and immediate postoperatively then two weeks after surgery while practicing the physiotherapy program. Again reassessment one week after last follow-up visit and another one after 6 months follow-up. Functional status was tested objectively through Performance-based tests included the Six Minute Walk Test [7, 8] Timed Up and Go test (TUG) [9].

-	Immediate P.O.	Last visit of F.U.	6 months P.O.

Clinical measures included hip range of motions (ROM) performed by two authors using a goniometer, Harris Hip Score (HHS) [10] and WOMAC activity Score [11]. To assess safety, descriptive data were reported. Safety was measured by assessing the number and type of adverse events during exercises treatment.

5. Results

After 6 weeks of training, the participants' showed greater change in 6-minute walking distance with mean increase 41.34%, and with a mean change of 117.12 meters. Up-and-go time test decreased 47.63% from the baseline measurements, with a mean change of 7.28 seconds. No cases showed high risk for falling. Clinical outcome measures showed that Passive range of hip motions was markedly improved at last follow-up visit by about 42.66%. The increase is more evident in hip flexors. Harris Hip Score (HHS) showed significant benefits from the program exercises with mean change of the score at last visit of follow-up 33.7 points. Changes of HHS shown in (Table I).

Pre-operative	42,5
Immediate P.O.	45.1
Last visit of F.U.	77.3
6 months P.O	87.2

Table 1: Changes of HHS shown.

Mean change of total WOMAC activity scores is shown in (Table 2).

Pain	48	74	86
Stiffness	47	69	79
Physical Functions	52	68	81

Table 2: Results for pain, stiffness, and physical functioning measured using the WOMAC subscales.

P.O. = postoperative.

F.U. = Follow up

WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index and revealed significant improvement of the score following exercises at last visit of follow-up and 6 months postoperative. Regarding safety no adverse events occurred during practicing the program of exercises for all patients.

6. Discussion

Total hip arthroplasty (THA) is considered the gold standard treatment of end-stage hip arthritis in the presence of relevant functional impairments when conservative treatment options have failed. Also; the number of person who undergo THA has increased significantly over the last few years in our country due to governmental treatment policies which depends largely on state's expense also owing to increased number of patients suspended on operative waiting lists. Those patients (particularly at end-stage arthritis) would have muscular, soft tissue disorders and proprioceptive deficit owing to modified hip anatomy and biomechanics prior to surgery. The later might cause relevant hip joint stiffness, deformity, deficient muscle strength and walking difficulty. Success of THA is due to its predictable pain relief, functional recovery and improvement in quality of life facilitating the patient's return to activities of daily living (ADLs) and even to labor activities [12]. Following surgery, variables rehabilitation programs had been proposed in clinical practice to strengthen the muscles, improve gait and coordination to optimize functional recovery [13]. Several studies supported such physiotherapy programs and showed better results when compared to minimal or even no intervention following THA [14, 15]. Not only joint functional gain was the benefit but also some studies emphasized that rehabilitation could reduce incidence of complications as prosthetic infection, osteoloysis, sublaxation or dislocation and variable thromboembolic disease [16].

Although there is still no routine rehabilitation protocol worldwide admitted after THA, However, most of these programs are supervised by healthcare professionals and are conducted using expensive training equipment's so; it is considered costly and inconvenient particularly for those patients who live in remote areas, lack personal transportation, or those who have restricted mobility [17]. Adding to these difficulties certain patient specific factors like capability and readiness of patient to come to physiotherapy center, availability of assistance and finical burden beside lack of availability of rehabilitation center and place to do that specially in suburban area and country side [18]. This may explain the low rates of adherence that are reported for these rehabilitation programs. Furthermore, because of lack of accessibility and financial considerations, these types of exercise programs are difficult for patients to continue by themselves after the completion of any research studies [19]. In this study, We propose a strategy of rehabilitation program which can be carried out at the outpatient clinic or monitored at home utilizing a low cost equipment. Using the Chest Expander Spring device in Physiotherapy-based exercise rehabilitation after total hip replacement with progressive increase in the exercise resistance according to the patient capacity and compliance. Also, we have evaluated the clinical and functional outcomes of the program which showed significant improvement of the results relative to preoperative state. The program has many advantages including: availability of its equipment's , low cost so no much financial burden, easiness to be done and monitored at home, office or even outdoor. Progression can be increased by increase the number of springs and duration of exercise which could be done by patient self and it does not need much human resources which is suitable for low income countries.

Our study has been supported by many previous reviews which stated that rehabilitation after hip and

knee replacement whether carried out at the clinic or monitored at home, appears beneficial but type, intensity and duration of interventions were not consistently associated with outcomes [20]. Coulter et al. [13]; Artz et al. [19] mentioned that home-based physical rehabilitation, i.e. having received one or a few initial exercise instructions, seems equally effective as out-patient, supervised rehabilitation. Bandholm et al., [6] concluded that there is a continuous major need to improve functional recovery after hip and knee replacement, because studies to date have not found superiority of one exercise regime over another. However, whilst exercise-based rehabilitation seems superior to no or minimal rehabilitation after THA and TKA, other authors emphasized that among patients who had completed standard rehabilitation after hip fracture, the use of home-based functionally oriented exercises resulted in improved physical function at 6 months and 9 months [21]. At the same time many authors declared that there were no statistical differences between patients who received exercise program under the supervision of the physiotherapist and the patients who were treated with standardized home-based exercise program for the efficacy of treatment in the evaluation of pain, functional status, quality of life, and depression status. When the rehabilitation programs were analyzed for cost effectiveness, the supervised physiotherapy group was found to have higher costs [21].

7. Conclusion

Physiotherapy can improve muscle power, range of motion and coordination after total hip replacement and help prevent complications such as subluxation and thromboembolic disease which is associated with a greater probability of earlier discharge, which is in turn associated with a lower total cost of care. Provides pain relief, promotes rehabilitation and the reintegration of patients into ADLs. It also provides a better quality of life through the patients' reintegration into social life Additionally, Patients who had completed rehabilitation program after hip arthroplasty the use of home-based functionally oriented exercises resulted in improved physical function. A low cost physiotherapy program can be utilized which is suitable for ruler, suburban area and country side.

8. Limitations of Our Study

Our study presents some limitations, namely small sample size. Also, follow-up period is somewhat short relatively and being an observational trial assessing short-term as well as medium-term clinical outcomes and lacking of comparative study. Additionally direct and indirect costs will be evaluated from a societal perspective. Study enrollment was not randomized and patients had a choice in where they received treatment, which may have affected outcomes.

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