

Physiotherapy and Rehabilitation in Restoration of Function Post THA – A Narrative Review

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Review Article

Volume 2 Issue 3

Received Date: March 08, 2018

Published Date: March 30, 2018

Abstract

Total hip arthroplasty (THA) is the surgery commonly performed to relieve pain & improve functions. Joint arthroplasty is now a mainstay for all the clients who are resistant to conservative remedies. According to the literature more than 90% of the patients report satisfaction post surgery as it has helped them return to their activities within 3-6 months. However a number of studies report strength deficits in the late post operative period raising a question on the intensity sufficiency of Physiotherapy & Rehabilitation targets in rehabilitation phase. This review was undertaken to study effects of Physiotherapy & Rehabilitation on function on follow-up. Various search engine/databases were searched with appropriate key words. Total numbers of studies identified from the databases were 39. Studies showed post operative weakness had several causes, physiotherapy & rehabilitation was important and advised in all in the initial post -op phase but few studied and analyzed its late effects.

Conclusion: Review suggests that Physiotherapy & Rehabilitation are important & intense supervised rehabilitation targeting hip abductors in weight bearing & / or non weight bearing are of tremendous value as it improves strength, functions & gait. The benefits are said to be achievable after adequate repetition & practice. Thus the patient needs to follow up and remain on regular program for maintenance and educated for the same.

Keywords: Exercise; Gait; Hip Replacement; Total; Rehabilitation; Maximal strength training; Therapy; Hip Muscles; Hip Abductors

Abbreviations: THA: Total Hip Arthroplasty; TKR: Total Knee Replacement; OA: Osteoarthritis.

Introduction

The hip replacement surgery, now a very common surgery done, was pioneered by Sir John Charnley, an

English Orthopedic Surgeon in 1960 [1]. It is now > 50 years of this surgery [2,3]. Total hip arthroplasty (THA) is the surgery commonly performed to relieve pain and improve functions in patients with severe arthritis, avascular necrosis, post traumatic fracture / injury, bone tumors of the hip joint etc [1,3-11]. The projection of THA being performed in huge numbers has almost doubled

and is expected to rise [11-13] to 2-10 folds, almost to 175% between 2005 & 2030 [13-15]. THA performed was 70 – 150 per 100,000 population and expected to rise as populations ages, lives longer and as greater percentage of population is obese [16]. Thoralf R. Liebs reported TKR & THA performed 100,000 & 500,000 resp. in UK & USA respectively every year [17].

THA is said to bring about tremendous pain relief but functional gains apparently as per literature are not enough to be able to restore normal status, as gait abnormalities are found to persist years after THA [1,5]. This may be due to inadequate rehabilitation and or other technical problems related to prosthesis and its fixation [1,5].

Large number of patients with THA have persistent long term impairments like muscle weakness esp. of hip abductors, although whole limb is weak, limping gait, in efficiency in gait, contracture, etc. are problems which in turn may lead to loosening of implant and joint instability [1,2,5,16,18,19].

Apart from adequate strength in whole limb, in particular strength in hip abductors is necessary for satisfactory gait pattern without limp. Hip abductors are said to be most important muscles of hip joint, because they are responsible for pelvic stability, this is especially so during uni-pedal stance [16]. It is known that in walking body transfers 1.3 to 5.8 times the body weight on each limb and this increases to 6-8 times during running & jumping [2,18]. Inefficiency of hip abductors leads to 'Trendelenburg gait' which leads to poor gait pattern, reduced hip extension, and these alterations may lead to loosening of implant [1,5,19].

Gluteus medius muscle activation patterns in patients with hip arthritis when compared to the healthy older adults during the single limb stance are found to be atypical. In cases of hip arthritis a number of studies demonstrate gait abnormalities, reduced mobility and strength of affected hip which is mainly due to the patient avoiding loading of painful joint [1,5,8].

The type of replacement is dependent on individual's age and activity levels; in general cemented type is preferred in elderly and non-cemented in younger client as failure of loading induced cement failure is not a risk [10]. A number of surgeons do not permit weight bearing on non cemented before 6 weeks, while cement can be permitted with immediate weight bearing [4,10].

THA operation commonly employs 04 approaches, anterior, anterolateral, posterior, lateral, and a combined approach is employed by some. Each has its relative merit & demerit [4,6,7,10,20,21]. The lateral approach disturbs the abductor mechanism and may lead to permanent sequelae like limping gait. The reason could be damage to the superior gluteal nerve or failure to reattach the muscle mass to greater trochanter, although good surgical skills may be a key to preserving this. The posterior approach is preferred as it avoids displacement of abductor mechanism [4,7,20-22].

The anterior approach rather new is said to be minimally invasive. Although demanding on the surgeon has an advantage of hip muscles not being disrupted during surgery. Here, patient needs precaution with external rotators [4,10,20,23]. To decrease the peri-operative complications associated with more extensile approaches and to speed the recovery of patients after THA, most surgeons now prefer minimally invasive approaches [4,10,22,24].

Gluteus Medius is primarily hip abductor, its anterior fibers are said to assist flexion & internal rotation and posterior fibres in external rotation & extension [1,19,25]. According to Margeret, et al. quantification of hip abductor strength has been infrequently done. Other muscles like quadriceps, hip flexors and extensors are also found by some to be weak [26].

Despite rehabilitation with emphasis on development of hip abductor mechanism it has been found that the abductors of the THA limb get atrophied and remain weak as compared to sound limb, it can be as low as 15% compared to the healthy limb [3,5,6,8,9,12,22,23,27,28].

The pattern of recovery in hip OA post THA is also not known as most of muscles have atrophied due to changes induced by chronic preoperative inactivity [22]. Thus, in cases of hip OA healthy limb is also seen to be weakened [8]. THA is commonly done in patients with hip OA. In these patients, preoperatively due to reduced activity and pain muscles of affected limb will show weakness and be atrophied. This is seen persistent post operatively too and may contribute to decreased ambulatory capacity. This could become a major risk post operatively leading to loosening of implant and joint instability.

According to Rasch A, et al. two years after THA, muscle atrophy was persistent in muscles acting about the hip [22]. They had found altered composition of muscles i.e. fat infiltration in hip and thigh muscles pre-operatively in patients awaiting THA and therefore suggested that either

surgery should be carried out early especially in cases of hip arthritis or a more intensive rehabilitation may reverse these changes post THA, this is emphasized by a number of researchers [5,6,9,12,22,24,28].

The ways surgeon can preserve hip abductor strength is by improving the mechanical leverage. This is done by increasing femoral offset of hip prosthesis. 'Femoral offset' (FO) is defined as perpendicular distance from long axis of the femur to the center of rotation of femoral head. Thus geometrically if the FO is greater, then the moment arm (leverage), the resultant force of the hip abductor muscles also is said to increase. Some studies report influence of FO on abductor strength [1,2,23]. One author hypothesizes that short stem position influences FO and abductor muscle strength [23]. 'Anatomical Femoral offset' is determined by neck shaft angle and 'Physiological offset' is determined by the femoral ante version angle. Persistent hip ante version results in weak abductors as greater trochanter shifts backwards thus reduce functional offset and lever arm.

Joint arthroplasty is now a mainstay for all clients who are resistant to conservative remedies [2,10,23]. According to the literature > 90% of the patients report satisfaction post surgery as it has helped them return to their activities within 3-6 months. Physiotherapy is begun invariably pre-operatively to educate patient and family, there may be counseling on reduction of weight and also for general conditioning. Post surgery physiotherapy is immediately advised and the attention is on improving mobility and strength such as to reduce chances of DVT and other dangers associated with immobility like pulmonary embolism, pneumonia, effects of general anesthesia etc [4]. In our hospital too post operatively rehabilitation is immediately instituted emphasis on early ambulation is laid but not necessarily progressive strength training [6,10].

However a number of studies report deficits in strength in late post operative period raising a question on intensity sufficiency of Physiotherapy targets in rehabilitation phase [1,3,6-10,22,24]. This review was undertaken to study the effects of Physiotherapy i.e. effects of hip muscles exercises on function on immediate & long term follow-up.

Methodology

The pub med and the other search engine/databases searched were: Cochrane database / SCIRE / PEDro / CINAHL/ EMBASE. The key words used were - Exercise;

Gait; Hip replacement, total; Rehabilitation, Maximal strength training, therapy, hip muscles, hip abductors.

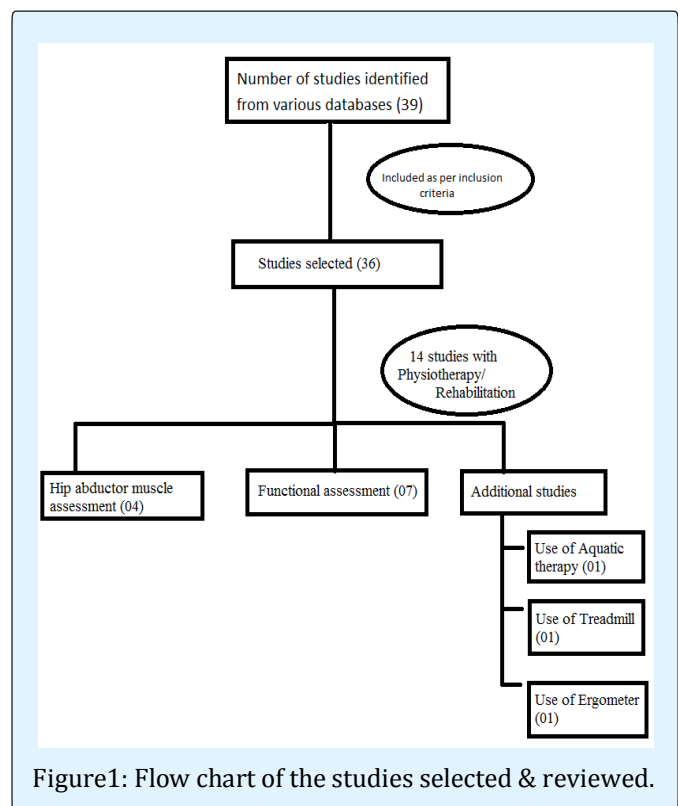
Inclusion Criteria

- Studies with exercises / rehabilitation programs described and initiated early / late phase of THA
- Studies with home program
- Design (clinical trials) Case control studies

Exclusion Criteria

- Previous surgeries on hip
- Pelvic dysplasia

(Figure 1) is as shown below:



Results

14 studies were considered suitable & reviewed in detail. Of which 11 studies were selected as they directly assessed effect of Physiotherapy & Rehabilitation on hip abductor muscle and its functional assessment. The additional studies were also basically similar except that they used Aquatic therapy, treadmill and ergometer to see the effect (Table 1).

S. No.	Title	Author and year of Publication	Study Design
1	Hip abductor strength following total hip arthroplasty. A prospective comparison of the posterior and lateral approach in 100 patients	Nicholas D Downing, et al. (2001) [20]	Prospective Study
2	Surgery-Induced Changes and Early Recovery of Hip-Muscle Strength, Leg-Press Power, and Functional Performance after Fast-Track Total Hip Arthroplasty_ A Prospective Cohort Study.	Holm, et al. (2013) [6]	Prospective cohort Study
3	Muscle strength, gait, and balance in 20 patients with hip osteoarthritis followed for 2 years after THA.	Anton Rasch ¹ , Nils Dalén ² , and Hans E Berg (2010) [24]	Prospective study
4	Isometric Hip Abductor Strength Following Total Hip Replacement and Its Relationship to Functional Assessments.	Margaret D. Vaz, et al. (1993) [26]	Observational study
5	Preoperative Predictors of Ambulation Ability at Different Time Points after Total Hip Arthroplasty in Patients with Osteoarthritis.	Akiko Kamimura, et al. (2014) [8]	Prospective observational Study
6	Total hip arthroplasty in the elderly: impact on functional performance.	Rita C. Guedes, et al. (2011) [9]	Observational study
7	Persisting muscle atrophy two years after replacement of the hip.	A. Rasch, et al. (2009) [22]	Observational study
8	A Targeted Home- and Center-Based Exercise Program for People After Total Hip Replacement: A Randomized Clinical Trial.	Mary P. Galea, et al. (2008) [27]	Randomized controlled trial
9	Treadmill training with partial body weight support after total hip arthroplasty: a randomized controlled trial.	Hesse, et al. (2003) [31]	Randomized controlled trial
10	Multicenter Randomized Controlled Trial Comparing Early Versus Late Aquatic Therapy After Total Hip or Knee Arthroplasty.	Liebs, et al. (2012) [15]	Multicenter Randomized Controlled Trial
11	Effect of a Walking Skill Training Program in Patients Who Have Undergone Total Hip Arthroplasty: Follow up One Year After Surgery.	Heiberg, et al. (2012) [29]	Randomized controlled study
12	Early Postoperative Maximal Strength Training Improves Work Efficiency 6–12 Months after Osteoarthritis- Induced Total Hip Arthroplasty in Patients Younger Than 60 Years.	Husby, et al. (2010) [30]	A single blind randomized controlled study design
13	At discharge gait speed and independence of patients provides challenges for rehabilitation after total joint arthroplasty: an observational study.	Husby VS, et al. (2009) [36]	randomized controlled study design
14	Ergometer Cycling After Hip or Knee Replacement Surgery: A Randomized Controlled Trial.	Thoralf R. Liebs, et al. (2010) [17]	Multi center-Randomized Controlled Trial

Table 1: The study titles, authors and the year of publications, study designs of various authors.

Discussion

Physiotherapists are team leaders of the Rehabilitation. The patient invariably, is necessarily referred for Physiotherapy post THA. This can be and at number of centers is initiated in the pre-op phase and extended to

variable times post operatively [4,10,11,26,29]. The preoperative instructions are more of education like dos & don'ts; educate patients about the Rehabilitation program, use of assistive devices especially based on the type of implant cemented / non cemented, etc. The post –

operative phase has 'protocols' in place and on surgeons instructions the weight bearing may be initiated.

The initial phase comprises of goals like - preventing circulatory complications, prevent movements that may lead to dislocation, general conditioning and weight loss may also be initiated. Mobility & strengthening program of the operated leg specifically like ankle pumps / ATM'S, quadriceps & gluteal sets, is initiated and also general program viz. assisting the patient to sit up at least 30 minutes, upper arm exercises along with chest care is added. Mobility is soon increased to include transfers on the bed, in and out of bed / ambulation as soon as it is possible with frame, generally the skills of the Physiotherapy may be continued till the patient is deemed to be safe in mobility with or without assistive devices and independent in performing the program. Gait training initiated as soon as possible. This then can be progressed to stairs & instrumental ADL's by 3-4 weeks. Beyond this the patient may be invariably on his own and may in some cases continue with cycling, swimming, gym program etc [4,10,18,29,30]

Late phase rehabilitation program has been recommended strongly by many [5,10,11,12,26,27]. There are recommendation of exercises to continue for 12 weeks for a minimum of thrice a week, and concentrate on the strength of the Glutei and the entire group forming the extensor apparatus for walking and this is expected to improve the gait & walking speed. Some also recommend the program for 4-12 months post operation and emphasis on load bearing exercises like sit to stand, unilateral heel raises, partial knee bends etc. The program extending to one year has also been tested and therefore it has been emphasized that the late phase programs are useful especially with regards to gluteus medius and weight bearing exercises. 66% of one RM load to increase the muscle strength and that load of 85-95% of 1RM to train the fast motor units has been recommended [16,30]. Caution is however advised with use of 'High impact activity'. Individually tailored programs are more beneficial [5,10,26,27]. Physiotherapy protocols however vary depending on the surgeons impositions also as on the clinical experience of physiotherapist. As the muscle strength declines by approximately 4% per day during the first week of immobilization, resistance exercises, weight bearing, endurance exercises are all important even in the initial phase [10]. The dislocations are said to most likely occur in the initial 3 months but never the less it may be seen occurring as late as 5 years post THA, thus importance of care and emphasis on 'Late Rehabilitation' [10]. The risk of dislocation is more likely to occur in the postero-lateral approach [10]. Nicholas D Downing et al

2001 assessed the hip abductor muscle strength of 2 groups with different approaches. Post operatively both the groups gained in strength and the change in strength was similar in both the groups at 3 months and also at 12 months. Trendelenburg test becoming negative as the strength improves. However the median change in strength at the 12 months was lesser in the lateral approach group as compared to the posterior approach group [20].

In the study Bente Holm, et al. the patients were operated using the standard posterior approach with uncemented THA. The results showed the strength increased from the 2nd day to the 8th day. The function assessed by TUG (Time up & go test) showed that while pre-op the patients walked unaided and had the TUG of 9.5±2.7s; 2nd day post op it became 18.3±6.5s with walking aid (crutches); and on the 8th day with only few using assistive devices the TUG improved to 11.7±3.4s. Self reported disability showed similar pattern. Although rate of rapid recovery is seen by the 8th day to almost the pre-op values the authors still reports persistent strength deficits years after surgery when compared to the contra lateral side or to the healthy age matched peers thus emphasizing on more intense type of Rehabilitation. There are indications that the muscle strength & performance based functions recover more quickly after supervised rehabilitation [6].

Anton Rasch, Nils Dalén, and Hans E Berg [22] in their study concluded that preoperatively patients with OA hip showed deficits in the muscle strength of all the hip extensor apparatus (except the hip adductors & knee flexors) 2 years after surgery there was persistent 6% deficit in all hip muscles, with hip abductors the worst affected showed 15% deficit. The quadriceps had improved 100% from the preoperative 27% deficit. Healthy limb showed no significant difference.

Margaret D Vaz, concluded that there was no significant difference in the muscle torques and the functional assessments between cemented & uncemented and none of the participants reported discomfort during the hip abductor tests. Post hoc analysis showed that in each successive testing the muscle torques were better than previous. However the relation between hip muscle torques and function was low. The functions improved considerably post surgery, largest gains in strength & functions occurring in the 1st 12 weeks. Akiko Kamimura, et al [8]. (physiotherapy program included manual mobility and strength and functional exercises. The combination of passive, active and resisted exercises were given and significant improvement in all the hip & knee

extensor muscles was seen and almost all the patient were seen to able to walk with or without support by 3 weeks. Hand held dynamometer was used to measure the isometric strength. The authors found that pre-operative knee extensor strength and not any hip muscle that was strongly associated with ambulation ability at 3 weeks while at 4 months preoperative hip abductor strength was more associated with ability to ambulate. Preoperative programs are feasible & effective in improving early recovery post THA. The author concludes that knee strength cut off of 0.56 and 0.24 Nm/ kg are cut off of hip abductors and age 73 years pre operatively were reliable predictors of ambulation ability at 3wks, 4 and 7 months resp. after THA [8].

Rita C Guedes, et al. concluded that the functional performance and the gait parameters were markedly low in the arthroplasty group compared to the healthy control even 2.3 years after THA [9]. The mean TUG in the arthroplasty group was 14.67 secs while the control group means TUG was 10.08 secs. In the age group of normals in 70-79 age group was determined to be 11.3 sec by the same author, this suggested worse functional performance. There is strong evidence of muscle weakness and reduced muscle mass because of muscle inhibition and reduced mass & weakness due to disuse of the contra lateral limb [9]. The mechanisms underlining the two are multi factorial. The literature suggests the need to address these issues. Satoshi Kamada, et al. reported that short stems of the prosthesis influences the femoral offset and hence the abductor muscle strength of the hip [3,12,13,23].

The early post operative protocols used are neither supported nor refuted. Early intensive rehabilitations are found to be beneficial. Similarly late stage rehabilitation post operative beyond 8 weeks also support usefulness, it is recommended that they utilize more weight bearing program. There are number of different methods utilized, there is a lack of standard protocol [12]. Studies lay emphasis on intense rehabilitation along with minimal invasion and less waiting. It is known that bed rest of 5-6 weeks in healthy adults profoundly atrophies knee extensors and calves compared to Hamstrings & glutei, this is thought to be due to influence of gravity [22,24]. However, in patients with osteoarthritis the observation is opposite all the muscles of the limb waste / atrophy this probably suggest that the weight bearing may not be the only influence in painful unloading of the limb. The author confirms full recovery after traditional rehabilitation and specific exercises for both the knee and calf but the hip remains slow in recovery. 9%-13% loss in knee muscle mass seen post THA.

Mary P Galea studied the effects of home based and center based program post THA [27]. According to the study some authors have found home based programs as effective as center based. It has been stated that unsupervised home based program also show increases in the muscle strength. The recent trends to decrease length of stay emphasize the need of an efficient and effective program beyond the initial week. Thus the authors studied intensive program extending to 8 weeks. The only limitation as accepted by the authors is that there was no control group who did not exercise; the exercises improved the functions post THA. 12 week home programme with good compliance also shows significant improvement in gait speed, functional performance and muscle strength [3,12,13,31].

Review shows use of treadmill with partial body weight support was better in the experimental group as most of the patients left the crutches earlier. Stefan Hesse, et al. state reasons to be physiological that treadmill allowed motor learning helping patients to practice complex gait patterns [31]. As aquatic therapy is commonly used in Europe the authors Thoralf R Liebs, et al. compared early versus late aquatic therapy after THA to study the timings the aquatic therapy be instituted [15]. The aquatic therapy is said to have number of advantages viz. the up thrust / buoyancy which helps relieves weight resulting in the ease of movement and the viscosity helps in protecting the joint at the same time increasing muscle strength, also different resistances can be experienced by altering the velocity of movements. Water provides security at the same time promotes balance apart from the hydrostatic force and warmth of water provides pain relief. The authors however concluded that although the aquatic therapy is effective after TKA the study do not support its use after THA [15].

Kristi Elisabeth Heiberg with regards the physiotherapy the author reports about the variation in the timings of initiating physiotherapy and the content of the program [29]. The reference for physiotherapy ranged from immediately post operative to several months or even years after surgery. While the program varied from range of motion exercises, strengthening exercises to cardio-respiratory training in the non weight bearing positions more from reviews the author states that it was not possible to establish effectiveness of various programs although all were seen to be significantly beneficial. The benefits are said to be achievable after adequate repetition & practice as it is possible especially in cases of THA post OA hip, the movement loss is due to inhibition of movement and hence needs to be relearned. The authors planned to study the immediate effects of

walking skill training on various activities like walking, stairs climbing, balance, physical functioning, pain & self efficacy. The author concluded that walking skill training program even 4-5 months post THA was effective in improving functioning, walking distances and improvement in stair climbing which persisted even at 12 months. James W. Youdas, et al. state that minimum 40-60% muscle activation is required to strengthen the muscle and their study showed that weight bearing limb gluteus medius could reach to the range of 50-60% and therefore can be used by the clinicians [32]. In their study lateral band exercises also activated the trunk muscles.

Liebs T, Herzberg W, Ruther W, Haasters j, Russlies M, Hassenpflug J studied the effect of ergometer cycling following TKR and THA [17]. They believe that cyclic movements of the legs like continuous passive motion would increase the proprioception, muscular coordination apart from the ROM. The standard protocol of ROM exercises, muscle strengthening, circulatory program, balance and coordination, gait and instructions of ADL's including walking stair climbing, transfers & walking on uneven surfaces were also given along with ergometer cycling 3 times a week. They found that ergometer cycling is beneficial after THA. This study however does not support the same in patients with TKR. It is said that maximal strength training resulting in neural adaptations is the appropriate way for rate of force development. The author (V S Husby) states that several studies support the maximal strength training results in the improved work efficiency [16]. M DI Monaco, C Castiglioni studied the effect of early maximal training post THA along with conventional program and compared to the group receiving only conventional [13]. The study concluded that early post-operative maximal strength training improved the work efficiency 6 and 12 months post operatively compared to the conventional group indicating that prolonged maximal muscle strength and aerobic endurance program are required to fully recover the THA patients. The authors tried to define what is optimal program (type and time) post THA- the however were unable to build up the type and time as there were sparse studies.

J Maire, et al. supposed that classical physiotherapy post THA is not sufficient as the patients post THA do not get back to doing their ADL's post THA and this leads to de conditioning with severe perturbations with the cardio-respiratory fitness and affects their overall health they therefore piloted the study use of incremental upper limb crank exercises for 1 month pre surgery and 2 months post THA in elderly patients they assessed effects on their health and endurance and found positive

significant improvement [33-35]. The subjects showed significant difference in the endurance assessing outcomes and hence the authors recommend adding this with the other exercises. Mattia Morri, Emanuela Natali and Daniele Tosarelli studied the mean level of autonomy achieved by the patients post THA [36]. Cohort prospectively was followed it was concluded that following discharge the gait speed was severely impaired. They suggested the challenge is to achieve walking efficiency and gender and age tailor made programs are required with special attention to the elderly women.

Conclusion

The review suggests that Physiotherapy and Rehabilitation provide better outcome post THA, & intense supervised rehabilitation targeting hip abductors in weight bearing and / or non weight bearing may be of tremendous value as it improves strength, functions and gait. The benefits are said to be achievable after adequate repetition and practice. Thus, the patient needs to follow up and remain on regular program for maintenance and educated for the same.

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