



Original article

The effects of resisted hip abductor strengthening in initial phase in patients with hip arthroplasty

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Abstract

Although hip arthroplasty (HA) is done to effectively reduce pain and improve mobility and hence quality of life (QOL), this may not effectively restore biomechanics and improve gait as strength of hip muscles have been reported to remain weaker when assessed after 1 year of HA. Several studies done for assessing effects of strengthening exercises for varying periods at follow-ups of different intervals have been reported. This study was done to assess the effects of resisted hip abductors program given in initial phase following total hip arthroplasty (THA). Consecutive patients of HA referred for physiotherapy satisfying inclusion criteria were recruited (N=15). Patients were divided in 2 groups. Control group (N=7) given conventional therapy and experimental (N=8) given conventional therapy and resisted isometric hip abductor strengthening. Harris hip score (HHS) and strength measurement with modified sphygmomanometer (MoS) was recorded in each group, on the 3rd and 8th post-operative day (POD). Normal individuals (N=30) with comparable age and gender were studied to estimate the hip abductor strength with MoS. 11 of total cases were following hip fracture, 4 were AVN. On 3rd POD both groups were similar for age, gender, strength and HHS. Both groups on 3rd day had mean strength 31.87±4.57 (mean of normal 101.4±12.80) mm of Hg. Strength and HHS within groups improved significantly (p<0.001) on 8th POD. However, mean difference in strength was statistically significant in experimental group compared to control group (p=0.016), no significant difference seen in HHS (p=0.70). The study concludes that resisted isometric hip abductor strengthening exercises started early along with conventional physiotherapy are beneficial.

Key words: Hip arthroplasty, Hip muscles strengthening, Resisted hip abductors, Total hip arthroplasty

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In the lower extremity reconstruction surgeries, one of the most advanced reported surgeries worldwide is the hip arthroplasty. It is said to be

'operation of the century'^{1,2}. In India itself 70,000 joint replacement surgeries are said to be performed annually³.

In general, there is preference for uncemented type of arthroplasty for the young and active and cemented implant for the older population and worse bone structure^{3,4}. Osteoarthritis of hip, a vascular necrosis, ankylosing spondylitis, failed fracture / dislocations of hip are the main indications for hip replacement surgery³. Hip replacement surgery approaches are classified based on their location relative to the anatomic structures.

The difference between the anterior and anterolateral is that one avoids compromising the hip abductor function as the incision is placed between the sartorius and tensor fascia latae while the antero-lateral exposes the gluteus medius^{5,6}. However, commonly used incisions are 'Lateral approaches', either anterolateral, lateral or postero-lateral and of these all require at least partial detachment of the glutei, but of these anterolateral and lateral lead more to hip abductor weakness and posterolateral shows increased tendency of dislocation⁵⁻¹⁰.

Although hip arthroplasty is done to effectively reduce pain and improve mobility and hence the quality of life¹¹⁻¹⁴, this however may not effectively restore biomechanics and improve gait^{15,16} as strength of hip muscles i.e. hip abductors, extensor and flexors have been reported to be weaker when assessed even after 1 year of hip arthroplasty^{12,14,15,17-19}.

The gluteus medius and minimus are primarily responsible for stabilising pelvis in unilateral stance, preventing pelvic drop. Due to hip muscles weakness especially, the hip abductors post total hip arthroplasty (THA) the lateral stability may be compromised associated with poor trunk control during body weight transfer from the operative to the non-operative lower extremity leading to balance problems²⁰⁻²². Jogi et al reported one in four patients to have a fall within 2 years following THA surgery²³.

Long term mild to moderate disabilities viz. pain, muscle weakness of hip abductors leading to loosening and joint instability, contracture of hip joint and gait disorders have been reported in patients post hip replacement^{15,17}.

Post operatively the patients following hip arthroplasty are referred for physiotherapy immediately by the 2nd POD and are made ambulant as soon as it can be possible. The hospital stay usually is not long, maximum extending to 10-15 days, if there is no complication. As the patient is already ambulant by 2nd day the concentration on specific strength component is invariably overlooked, thus in the long term problems associated with Hip Ab-

ductor weakness persists even though the overall functions are unaffected.

This study was planned to see if initial strength building program in addition to the walking made any difference to overall function of these patients at the point of discharge. The aim was to study effects of resisted hip abductors strengthening program on strength and function, given in initial phase in patients following hip arthroplasty. The objectives were to study the effects of resisted hip abductors strengthening exercises by modified Sphygmomanometer (MoS) and to study the effects of resisted hip abductors strengthening on functional outcome by Harris hip score (HHS).

Materials and methods

The proposed study was approved by the Institutional Ethical Committee of the University - Sumandeep Vidyapeeth Institutional Ethical Committee; approval number-SVIEC/ON/PHYS/BNMPT15/D1600 dated 12th March 2016.

Research design: Interventional, non-randomized control trial. Allotment was on alternate basis as consecutive patients were to be included.

Source of data: Dhiraj General Hospital

Sample size: All consecutive patients of hip replacement referred for physiotherapy

Pilot study for normative data was done. Normal healthy (self-declared) individuals with comparable age and both gender for this were 30 i.e. 60 legs (both limbs). The hip abductor strength with Sphygmomanometer was established.

Inclusion criteria

- Subjects following hip arthroplasty after they are referred for physiotherapy
- Adults >18 years

Exclusion criteria

- Subject with spine and lower limb pathology
- Subject with neurological disorder related to lower limb
- Unwillingness to participate

Tools and materials

1. Sphygmomanometer (Fig 1)
2. HHS questionnaire

Methodology

After obtaining approval from Institutional Ethical Committee, consecutive patients with hip arthroplasty referred for physiotherapy were re-

cruited for the study. Patients were explained about the study, and informed consent was obtained from participants who were willing to participate. Patient information sheet was provided to the participants, which explained about assessment and treatments involved in the study. Subjects were assessed in detail on the day of referral for physiotherapy following their consent; those who satisfy the inclusion criteria were recruited. Subjects were allotted to either control group (conventional physiotherapy) or experimental group (physiotherapy including resistance exercises) on alternate sequence.



Fig 1. Sphygmomanometer (aneroid manometer)

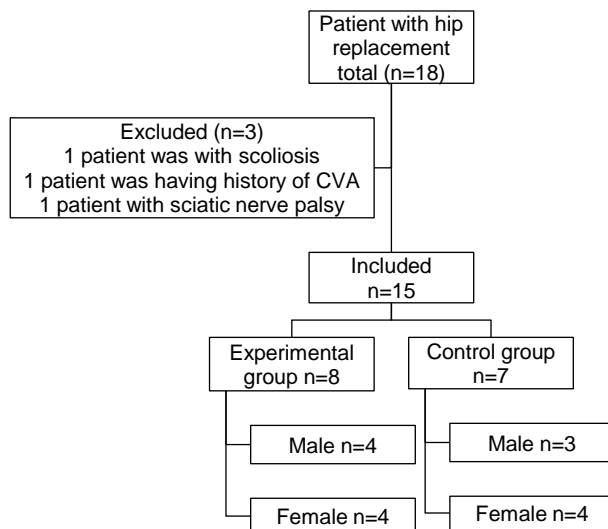


Fig 2. Flow chart of recruitment as shown below

Participants were assessed in detail including demographic data, history, date of surgery, type of

surgery, approach of incision, visual analogue scale (VAS), swelling, spasm, tenderness, range of motion, strength (MMT), limb length measurement and girth measurement.

Control group received conventional treatment from the day patient was referred for physiotherapy till the day of discharge. (Details below)

Physiotherapy treatment protocol for control group

Bedside exercises (before drain removed)

- Quadriceps sets
- Gluteal sets
- Ankle pump

Progress to following exercises after drain removed in addition to above i.e.

- Heel slides
- Passive/active assisted hip abduction progress to active hip abduction in supine position
- Terminal knee extension
- High sitting knee flexion extension
- Gait training with weight bearing as tolerated (on recommendation of surgeon on based on cemented vs. non-cemented) and progressing to cane or independent ambulation

The above-mentioned exercise will be performed with using precaution as below:

- Avoid hip flexion >90°
- Avoid adduction and internal rotation beyond neutral

Advice will be given for taking precaution in ADL

- Transfer the sound side from bed to chair or chair to bed.
- Do not cross the leg
- Keep the knees slightly lower than the hips when sitting
- Avoid sitting in low soft chair
- Use a raised toilet seat
- Avoid bending the trunk over the legs when rising from and sitting down in a chair
- When ascending the stairs, lead with the sound leg. When descending leading with the operated limb
- Pivot on sound lower extremity
- Avoid standing activities that involve rotating the body toward the operated extremity

Experimental group received same treatment as control group with additional isometric hip abductor strengthening exercise (within the tolerance) as additional treatment post removal of drain (as seen in Fig 3) till the day of discharge.



Fig 3. Isometric hip abductor strengthening exercise

Outcome measures

1. Visual analogue scale (VAS)
2. Strength of abductor was taken with sphygmomanometer – procedure as described below (Fig 4)
3. Harris hip score (HHS)



Fig 4. Strength of abductor was taken with sphygmomanometer

All outcomes were taken at the 3rd POD and at the 8th POD.

Hip muscle strength test methodology

- The sphygmomanometer was used for conducting the strength test, the instrument was first inflated to register 20 mm of mercury and the therapist placed patient's left or right hand inside the cuff, depending on which limb and movement was being tested
- The valve of the Sphygmomanometer remained closed to prevent any release of air
- Hold test was used for recording the strength values

- After each test, the pressure within the cuff was totally released and the procedure was repeated from the first step. 3 trials were conducted.

Procedure

- The test for hip abduction (Fig 4) was conducted with the subject in supine position.
- In order to test the left leg, the therapist stood left side of the subject, with the subject's leg in neutral position.
- The therapist, having placed the cuff on the right hand and positioned it on just above the knee lateral side.
- The test was started by asking the patient to move his leg outside by pushing the therapist hand and asked the patient put his maximum effort. Therapist resisted this action with maintaining the same position and not allowing the patient to do abduction. The maximum pressure exerted on the cuff was then recorded and the subject was asked to relax for 30-35 seconds before the second test was performed.

The maximum effort of the three trials was recorded. The actual effort was (maximum of three) - 20 mm of Hg.

Statistical analysis

1. All statistical analyses were performed with SPSS (Statistical Package for Social Science) version 16 software.
2. Descriptive statistics including Mean, Standard Deviation (SD) and Standard Error Mean (SEM) were calculated.
3. Independent t test was applied to compare inter group comparison by Mean values, Standard Deviation, Standard Error of Mean and P – value.
4. Paired t test was applied to compare intra group comparison in Mean values, Standard Deviation, Standard Error of Mean and p value.
5. One sample t test was applied to compare mean strength of normal and mean strength of operated limb.

Results

Total patients with hip replacement were 18 (03 excluded). Total number of the hip operated cases were 15 (11 patients were following fracture and 4 were with AVN). In experimental group total no. was 8 and in control group total no. was 7. Age ranged from 40 to 83 years. 9 were cemented and 6 were un-cemented. 13 patients were operated with postero-lateral approach and 2 with lateral approach.

Table 1: Comparison of baseline characteristics of two groups on the 3rd POD

	Group	N	Mean	SD	SEM	p
Age (years)	Experimental	8	57.88	7.18	2.54	0.821
	Control	7	59.43	17.44	6.59	
VAS 3 rd POD	Experimental	8	2.78	0.43	0.15	0.941
	Control	7	2.80	0.83	0.31	
Strength (mm Hg) 3 rd POD	Experimental	8	33.25	4.40	1.56	0.22
	Control	7	30.29	4.54	1.71	
HSS 3 rd POD	Experimental	8	52.38	4.17	1.48	0.061
	Control	7	46.57	6.66	2.52	

Table 2: Comparison of mean strength of both experimental and control group on the 3rd POD with mean strength of normal

Strength (mm Hg) 3 rd POD	N	Mean	SD	SEM	p
Experimental	8	33.25	4.40	1.56	<0.001
Control	7	30.29	4.54	1.71	<0.001

Normal value = 101.4 mm Hg

Table 3: Comparison of mean difference in strength and HHS in the control group between 3rd and 8th POD

Difference between 3 rd and 8 th POD	Mean difference	SD	SEM	p
Strength (mm Hg) Control	-14.57	3.59	1.36	<0.001
HHS Control	-21.71	7.16	2.71	<0.001
Strength (mm Hg) Experimental	-21.00	5.13	1.81	<0.001
HHS Experimental	-22.87	4.12	1.46	<0.001

Table 4: Comparison of mean strength and HHS and difference of mean strength and HHS between the two groups

	Group	N	Mean	SD	SEM	p
Strength	8 th POD Experimental	8	54.25	9.22	3.26	0.057
	8 th POD Control	7	44.86	7.99	3.02	
	Difference between 3 rd and 8 th POD Experimental	8	21.00	5.13	1.81	0.016
	Difference between 3 rd and 8 th POD Control	7	14.57	3.60	1.36	
HHS	8 th POD Experimental	8	75.25	2.19	0.77	0.058
	8 th POD Control	7	68.29	9.23	3.50	
	Difference between 3 rd and 8 th POD Experimental	8	22.88	4.12	1.46	0.702
	Difference between 3 rd and 8 th POD Control	7	21.71	7.16	2.70	

Discussion

The present study was planned to see the effects of resisted hip abductors given in the initial phase fol-

lowing THA. Routinely the patient is mobilized soon post operatively i.e. on the 3rd day and thus the structured resisted hip program many a times may be overlooked.

A number of studies have been done to evaluate the effect of hip muscles strengthening following THA^{15,20,22,25,26}, as the approach that the surgeon takes invariably involves the abductors directly or indirectly and also as number of studies which have followed up these cases up to 2 years or more have reported the hip muscles and knee muscles to remain weak compared to the contra lateral sound limb^{11,26}. Similarly, Fukumoto et al (2013) also reported that although hip and knee muscles strength improved considerably 6 months post THA on the involved side, the hip abductors always remained significantly below the level when compared to the healthy group²⁰.

The present study used the sphygmomanometer (aneroid manometer) to assess the strength. The norms were prior established by the same method in the age matched normal population (mean age 51.6±7.03) in 30 subjects (60 hips), the average strength was noted as 101.4±12.80 mm of Hg. A number of studies have been done to assess the validity and reliability of use of Modified Sphygmomanometer (MoS). All the studies established adequate criterion related validity, test-retest and inter-rater reliabilities for the assessment of strength, for the majority of the assessed muscles^{27,28}.

It has been reported that use of MoS easily trainable and that only one familiarization could yield reliable results and this method of assessment was not time consuming^{27,28}.

However, Sherrington et al (2005) investigated the test-retest reliability of various tools viz. measures of strength, balance, gait and functional performance in older people following hip fracture. With regards to Sphygmomanometer the author sounds caution as it was found to have a curvilinear relation with hand held dynamometer i.e. did not provide comparable measurement throughout the range²⁹.

13 of 15 subjects in present study were with postero-lateral approach with reconstruction of the posterior aspect. Reconstruction of posterior capsule, piriformis tendon and external rotators has been reported to be enhancing the stability of primary THA^{6,10}. Two of the cases in the present study were with lateral approach.

Number of studies reported no significant difference in hip abductor strength recovery and other outcomes between the two approaches i.e. lateral and posterolateral^{8,9,24}. The study durations of follow ups were different. One study followed up at 3 months and at 1 year⁸, other followed up at the end of one year⁹, third study assessed at the end of 2 years²⁴.

The outcome measures used few of them i.e. pain, hip abductor strength, Trendelenburg test, HHS, etc.

The strength of hip abductor muscle on the 3rd day post-operative compared to normal was significantly reduced in both the groups (Table 2). As seen the reduction in strength post-operative was almost 70%. Early loss of the strength in the muscles close to the operated hip joint is referred to as 'arthrogenic muscle inhibition' i.e. inhibition from CNS to activate muscles due to intra articular swelling, inflammation, pain and joint laxity. Overtime this leads to muscle atrophy¹⁴.

In the present study the experimental group received manual isometric strengthening for the hip in addition to the conventional physiotherapy. The hip abductor strength was assessed in both the experimental and control group. Within each group significant improvement in strength was seen on the 8th post-op day (Table 3). It is similarly reported that early rehabilitation with either standard physiotherapy and standard physiotherapy with isometric exercise program both show improvement²⁵, also that as the days progress post operatively the weakness becomes less pronounced at the end of the week^{14,25}.

In the initial comparison not only is the strength improved on the 8th day as compared to 3rd post-op day, also the HHS shows improvement within each group, i.e. <70 (poor) to 70-80 (fair) on the 8th day. This was so except in one case in the control group who was with bilateral AVN, also with uncemented THA and therefore immobilized, in the present study. In HHS mainly, the change was in the scoring of pain with analgesics ongoing and also there was improvement in the distance walked and ability to climb stairs.

Inter group comparisons, analysing mean difference in strength, showed experiment group to be significantly better compared to the control / conventional therapy group. This is in agreement to a number of studies comparing the same although at similar and / or at different intervals post operatively^{15,20,22,25,26}.

Early rehabilitation with either standard physiotherapy and standard physiotherapy with isometric exercise program both show improvement with experimental group showing better progress than the control group treated with standard protocol²⁵.

Similarly, Husby et al (2009) studied the comparison between the strength training group and conventional PT group following THA at 1st week and 5th week. Both the groups were given physiothera-

py for 3-5 times per week for four weeks. Both were similar on the assessment at 1st week but at 5th week, the group that had received resisted strength training in the first week was significantly better in strength, work patterns, gait and QOL compared to the conventional PT group¹⁵.

The same author (2010) also reports that at 6-12 months follow up too, the group that received maximal strength training early postoperative along with the conventional PT showed significantly better work efficiency compared to only conventional PT. However, the author emphasises that prolonged strength and endurance training is required to be continued for full recovery in the patients following THA²².

Rasch et al (2010) studied elderly patients before THA and at 6 months and at 2 years post-surgery. These patients post operatively had 10 sessions of weekly group training after operation and were then put on home program. At the follow ups the compliance amongst them varied ranging from no exercises to exercising several times per week. The patients showed weakness persisting in the hip muscles compared to contra lateral sound limb, which was more at the end of 2 years as compared to the 6 months assessment, although gait and balance had recovered. To prevent the weakness of the hip muscles the authors' recommended intense program targeting hip abductor strengthening²⁶.

Hip extensor and flexor strength and endurance is important following THA to avoid post-op limping as impaired muscle strength, endurance in these muscles, and limping severity were strongly associated postoperatively than preoperatively¹⁸. Similarly, Fukumoto et al also reported (2013) that although hip and knee muscles strength improved considerably 6 months post THA on the involved side, the hip abductors always remained significantly below the level when compared to the healthy group²⁰.

Late phase rehabilitation following THA has also been found to be associated with significant improvements in muscle strength, postural stability, and self-perceived function in patients 4 to 12 months after THA¹⁹.

Conclusion

The study concludes:

1. Early phase rehabilitation within the groups, in both experiment and control showed significant improvement in strength and HHS.

2. Mean difference of strength comparison between groups showed experiment group to be significantly better than the control, HHS showed no significant difference.

The present study therefore concludes that resisted hip muscles exercises must be started early in the phase of rehabilitation and based on the reports from the literature be continued for maintenance.

Scope of further studies will be able to convincingly prove the lasting effects and / or requirement of continuous Rehabilitation measures with periodic regular follow ups.

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Conflict of interest: None

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