Post-op Physiotherapy Management of Total Hip Arthroplasty

Tate and Sculco (1998) describe total hip arthroplasty (THA) as an operative procedure in which the diseased hip joint is resected and replaced with a synthetic acetabulum, head of femur, polyethylene liner and fixed to the bone by cement or bone outgrowths (i.e. figure 1). THA is performed to treat joint failure commonly caused by ankylosing spondylitis, rheumatoid arthritis, osteoarthritis, avascular necrosis (Porter, 2003). Osteoarthritis is the most common pre-operative diagnosis for THA (Katz et al., 1996). The goal of THA surgery is to provide a long lasting artificial joint that relieves pain and improves function while minimising or avoiding surgical complications (Brander et al., 2000).

The prevalence of THA in elderly population is 5.3% (Williams et. al., 1994). Osteoarthritis accounts for approximately 70% of elective THA surgeries (Siopack and Jergessen, 1995). Lim et al. (1999) reported that more than 280,000 THA procedures are performed annually in the United States, with more than 90% of patients reporting less pain and greater function at ten years of post-THA surgery compared to their preoperative pain and function. Based on self- report data in THA patients, Shields et al. (1999) associated pain relief and improvement in hip functions to THA surgery. Improvement in health care and standard of living of people in this decade may lead to increase in elderly population. This may also lead to increase in THA surgery. Hence, the demand for post-op physiotherapy management of these patients will increase. This makes progresses in post-op physiotherapy management of THA patients vital for all physiotherapists involved in orthopaedic as they would account for the bulk of their caseload.

(http://zimmer.com)
Figure 1. Anatomical diagram of hip joint with implants in place.

Anatomy: The hip joint is a multiaxial, spherical, ball and socket joint with high levels of congruency (stability and surface area for stress transmission) and extensive range of motion (Porter, 2003). It is the deepest and largest joint in the body (Porter, 2003). It is made up of the upper end of the femur and acetabulum of the pelvis (Moore and Agur, 2007). Degenerative changes coupled with pain resulting from arthritis at the hip joint may limit mobility from a place to another due to locomotion function of the lower limb (Porter, 2003). Activities of daily living are also hindered due to decrease movement at the hip joint (Brander et al., 2000) and these will necessitate THA surgery. THA is usually the last procedure done after other conservative treatment (weight loss, lifestyle modifications, ambulation with walking aids, physiotherapy, medication for pain relief etc) has failed (Brander et al., 2000).

Surgical operation: The posterior and direct lateral surgical approaches are commonly used for THA surgeries (Brigitte and Earl, 2006). The posterior approach involve cutting from behind (i.e. through the hip extensors, lateral rotators) and is associated with prosthesis dislocation, postoperative Trendelenburg gait and sciatic nerve palsy (Brigitte and Earl, 2006). The direct lateral approach involve cutting from the side (i.e. through the hip abductors, medial rotators) and this facilitates cup positioning which decreases rate of hip dislocation and diminishes the risk of injury to sciatic nerve (Brigitte and Earl, 2006). The reconstructed hip joint may be cemented together or left uncemented with bony outgrowth aimed at holding the joint in place (Porter, 2003). The operating time is approximately ninety minutes and the patient is return to the recovery ward from the operating room when medically stable after surgery (Porter, 2003). An abduction pillow is placed between the legs when the patient is lying or side lying to prevent dislocation of the hip (Porter, 2003).

Complications: The common complications of THA are infection, dislocation, deep vein thrombosis, pulmonary embolism, anaemia, swollen ankle, back pain, arm pain, stiffness after immobility, limp length discrepancy(Porter, 2003). Adequate medical care is given to prevent these complications by all members of the medical team (Porter, 2003).

Early post-op physiotherapy rehabilitation after THA (i.e. week 1-4): This focuses on restoring mobility, strength, reducing pain, preventing deep vein thrombosis, flexibility, teaching adherence to range of motion and weight bearing precautions (Brander et al., 2000). Early ambulation is associated with lower incidence of symptomatic thromboembolism after THA (Hass, 2001). Hence, physiotherapy is commenced once patient is medically stable in the recovery ward. Elastic compression stockings, intermittent pneumatic compression devices, active ankle pump, heel sliding exercises are commonly incorporated in physiotherapy management aimed to prevent deep vein thrombosis (Porter, 2003). Porter (2003) also highlighted daily post-op physiotherapy management of THA patients based on commonly accepted physiotherapy intervention in different hospitals as follows.

Day 1: Active exercises for circulation, static exercises for muscle tone around the hip, supine hip and knee assisted flexion exercises and deep breathing exercises are started.

Day 2: Partial weight bearing mobilization starting with three point gait on elbow crutches or walking frame only if necessary is started under supervision of the physiotherapist for cemented prosthesis but delayed for six weeks in uncemented prosthesis to allow for bony outgrowths strong enough to hold the joint in place. Patients are progressed from walking with walking frame to elbow crutches to walking sticks/canes. Techniques to safely manage stairs, steps and ramps are taught according to patient's home circumstances. Active assisted range of motion and strengthening exercises are also started.

Day 3 onward: Mobility is progressed on daily basis. Patient is supervised until he/she has good dynamic balance, correct gait with walking aids, and is competent at hip protection (i.e. minimising wear to the prosthesis). THA patients are advised not twist/pivot their hip in

either standing or sitting. Isometric hip abduction or isotonic hip abduction exercises against gravity are restricted in cases involving trochanteric osteotomy (Brander et al., 2000).

After discharge: In cases of posterior surgical approach, the patient may be issued with elbow crutches ambulating with three point gait and advised to gradually increase weight bearing by ambulating with two point gait and weaning to walking stick over the next six weeks (Brander et al., 2000). In direct lateral approach involving trochanteric osteotomy (i.e. suturing of the dissected greater trochanter to the neck of femur), the site of bony union must be protected for twelve weeks (Brander et al., 2000). The patient remains on elbow crutches ambulating with three point gait for a minimum of six weeks but then can start to gradually increase weight bearing by weaning to two point gait and to walking sticks until ready for full weight bearing at twelve weeks (Brander et al., 2000). Patients are advised to avoid high impact activities (e.g. jumping, running, jogging etc) as high pressure causes the most wear to the plastic prosthesis which may necessitate a revision surgery (Brander et al., 2000). McGrory et al.(1995) recommends diving, cycling, golfing and bowling as acceptable sports after THA in the late phase of rehabilitation (i.e after 4 weeks of THA surgery) while discouraging activities such as running, water-skiing, cross-country skiing, football, baseball, hockey, handball, karate, soccer and racquetball based on survey of orthopaedic surgeons recommendations and THA literature. Home programmes and outpatient rehabilitation programmes are designed based on the patient's needs and departmental policy upon discharge from the hospital (Porter, 2003).

The American academy of orthopaedic surgeons (2000) in collaboration with physical therapists gave the following exercises to be done by THA patients during early post-op period (i.e. week 1-4 post THA surgery). Ankle pumps, ankle rotations, bed-supported knee bends, abduction exercise, buttock contractions, quadriceps set, standing knee raises, standing hip abduction, standing hip extensions, walking with walker using two point gait (partial weight bearing for uncemented prosthesis during the initial six weeks) or four point gait (full weight bearing for cemented prosthesis), stair climbing and descending. They recommended

that these exercises should be done within 20-30minutes and repeated twice or thrice daily. Resistive hip flexion, abduction and extension exercises using elastic tube attached to the operated ankle in standing are incorporated during the late phase of rehabilitation (i.e. week 4 upwards after THA surgery) to strengthen the hip muscles. Exercycling/bicycle ergometer cycling against minimal resistance is also included. These late phase exercises should be done 20-30 minutes, 3-4 times daily.

Some restrictions are usually encouraged to prevent dislocation of the reconstructed hip until three months after the surgery when complete tissue healing is expected (Brander et al., 2000). Patients with cemented femoral stems are prescribed partial weight bearing, usually defined as allowing pressure of about 70% of body weight or full weight bearing while uncemented femoral stems are prescribed restricted weight bearing, either partial or `touch-down´ weight bearing restrictions, which allows pressure of 10% to 15% of body weight, for 6-12 weeks after surgery (Brander et al., 2000) in order to prevent dislocation of the uncemented remodelled hip joint. Also, weight bearing aids (elbow crutches) should be used during stair climbing and sit to stand manoeuvres in the early post-op period. In cases of posterior surgical approach, hip flexion of more than right angle degree, hip adduction, and internal rotation beyond midline should be avoided to protect against posterior dislocation (Brander et al., 2000). Hip abductor splints, elevated toilet seats, long handled sponges and reachers are prescribed to help avoid excessive hip motion during functional activity which could lead to dislocation of the hip (Porter, 2003). These restrictions are usually relaxed by three months when it is expected that there would be full tissue and bony healing (McGrory et al.).

Impairments that commonly persist after THA surgery include decreased hip extensors, lateral rotators strength in posterior approach; decreased hip abductors, medial rotators strength in direct lateral approach; decrease hip range of motion and postural stability on the

side of the replaced hip (Trudelle-Jackson et al., 2002). Weakness of the muscles of the operated hip, primarily in the hip abductors, is a major risk associated with joint instability, prosthesis loosening, or other complications in THA patients (Long and Dorr, 1993). Functional limitations that commonly persist are reduced walking speed and ability to climb stairs, and overall lower ratings on various assessment tools used to measure function after THA surgery (Trudelle-Jackson et al., 2002). The following studies are used to highlight problems associated with THA and the impacts physiotherapy can play to alleviate these problems.

Braeken et al. (1997) carried out a retrospective cohort study on THA patients, 6-12 month postoperatively. Pain was assessed using a ten-point scale (0 represent no pain while 10 represent worst pain). One hundred and ninety three THA patients were recruited. All THA patients had physiotherapy treatment while in the ward and after discharge from the hospital. The mean pre-operative pain was 7.5 while the mean post-operative pain was 2.43. The difference in pre-op and post-op pain was statistically significant ($p = 0.0001$). Braeken et al. (1997) concluded that pain relief reported was due to THA surgery and physiotherapy treatment.

Nallegowda et al. (2003) conducted a study on THA patients involving gait assessment. Thirty THA patients and thirty aged, sex-matched healthy subjects were recruited. The subjects' feet were stained with chalk powder and they were asked to walk on black foam mat. The time taken to walk a distance of 5 meters was recorded using a stopwatch. The data collected for gait parameters are as follows.

Table 1. Gait parameters in THA patients and control subjects

	THA group	control group
Cadence (steps/sec)	1.63	2.00
Stride length (cm)	98.73	136.60
Step length (cm)	48.20	66.90
Velocity (cm/sec)	84.00	124.00

There was statistically significant decrease in cadence (i.e. 1.63 steps/sec in THA group against 2.00 steps/sec in control group; p ‹ 0.001) velocity (i.e. 84 cm/sec in THA group against 124 cm/sec in control; p ‹ 0.001), stride length and step length (i.e. 98.73 cm and 48.20 cm in THA group against 136.60 cm and 66.90 cm in control group respectively; p ‹ 0.001) of the THA group compared to control group was seen. Nallegowda et al.(2003) suggested that the decrease in THA patients gait parameters compared to the control may be used to improves their balance (ability to maintain centre of gravity over the base of support) while ambulating.

Bertocci et al. (2004) conducted a research in which muscle strength of hip flexors, extensors and abductors were measured after four months of THA surgery and also in healthy control subjects. Twenty THA patients and twenty two community dwelling aged-matched healthy subjects participated. Isokinetic dynamometer was used to asses hip muscle strength of the operated hip, non-operated hip in THA patients and both hips in the control group. THA patients received both inpatient and an average of thirteen sessions of outpatient or home based physiotherapy treatment prior to assessment. The average values of both hips in the control subjects were used for data analysis. The data collected for operated hip and non-operated hip and healthy control are as follows.

Table 1. Operated hip, non-operated hip and control subject data

	Operated hip	non-operated hip	control
Hip flexors (ft-lbs)	353	360	729
Hip extensors (ft-lbs)	370	371	597
Hip abductors (ft-lbs)	19	23	96

There was no significant difference in the operated hip and non-operated hip of THA patients. Decrease in operated hip compared to the non-operated hip muscles strength as been reported (Long and Dorr, 1993). This indicates that physiotherapy intervention had significantly increased the operated hip muscle strength to the level of the non-operated hip of THA patients. THA patients were weaker than the control subjects i.e. control hip flexors was 2.1

times greater than the operated hip flexors (729 ft-lbs against 353 ft-lbs, p ‹ 0.001), control hip extensors was 1.6 times greater than the operated hip extensors (597 ft-lbs against 370 ft-lbs, p = 0.004) and also the control hip abductors was 5.0 times greater than the operated hip (96 ft-lbs to 19 ft-lbs, p = 0.006). The decrease in operated hip muscles compared to the control subjects indicates the need for continuous physiotherapy over a long period of time as four months physiotherapy was not sufficient to increase THA patients' hip muscles strength to the level of their control subjects.

Frost et al. (2006) did a study on THA patients in which isometric hip muscle strength per body weight was measured. Twenty two THA patients and thirty eight age and sex matched community dwelling were recruited. THA patients received both inpatient and an average of thirteen session of outpatient or home based physiotherapy treatment. THA patients recruited were 4 months post surgery. Isokinetic dynamometer was used to assess hip isometric strength. The data obtained for operated and non-operated THA hips and average values of both hips in the control group are presented below.

Table 1. Hip muscle strength in THA and control subjects

Movement	hip joint	peak torque/body weight (ft•lb/lb)
Flexion	operated	6.96
	non-operated	8.26
	control	11.56
Extension	operated	46.35
	non-operated	45.42
	control	53.22
Abduction	operated	15.52
	non-operated	12.98
	control	18.36

There was no statistically significant difference between the operated and non-operated hip in THA patients in either flexion (p =0.23), extension (p = 0.87) or abduction (p = 0.99). This finding agrees with Bertocci et al. (2004) in which four months of physiotherapy intervention had increase operated hip muscles strength to the level of the non-operated hip. THA patients operated and non-operated hips generated statistically significantly less peak torque per body

weight during flexion than the control subjects (6.96 ft-lb/lb, 8.26 ft-lb/lb against 11.56 ft-lb/lb; p = 0.3). THA patients also generated less peak torque per body weight during hip extension and abduction but the decrease was not statistically significant (p = 0.55, p = 0.17 respectively). The decrease in THA patients compared to the control subjects aggress with Bertocci et al.(2004) and also shows that four months of physiotherapy intervention was not sufficient to increase hip muscle strength of THA patients to the level of their aged matched control subjects.

Sliwinski et al. (2006) conducted a study on gait, quality of life and their association following total hip arthroplasty in elderly patients. Sixteen THA patients (9 females, 7 males) and sixteen healthy elderly adults (11 females, 5 males) were recruited. No significant difference was found between the two groups for age, weight, height, lower limb length and body mass index. Walking speed, cadence, step length and double support time was assessed using three dimensional VICON motion analysis system. The Medical Outcome Survey Short Form 36-item Health Survey (SF-36) was used to assess the quality of life in both groups. Assessment in THA patients were done between 2-6 months post surgery. THA patients received both inpatient and outpatient physiotherapy treatment. The average value of both lower limbs data in the two groups was used for data analysis. The mean walking velocity was significantly slower for THA group (1.1±0.2m/sec) than for the healthy group (1.3±0.2m/sec). The cadence of the THA group (104.6±10.8steps/min) was significantly decreased than that of the healthy group (113.1±12.7steps/min). The step length in THA patients (1.2±0.2m) was significantly shorter than in the healthy subjects (1.3±0.2m). Double support time was significantly longer in THA patients (0.4±0.2sec) than in the healthy group (0.4±0.1sec). These results show that THA patients had decreased walking velocity, decreased stride length and cadence. They also spent longer time in double support stance phase of the gait cycle. These may be done to provide for an increased stability during self-selected walking velocities in THA patients. The physical functioning score was 23.8 points

lower for the THA group compared to the healthy group and the role-physical score, indicating role limitations due to physical health problems, was 35.9 points lower for the THA group compared to the control group using SF-36 questionnaires. The results also shows that individuals with THA perceived themselves as being more limited in performing activities of daily living in comparison to healthy group by recording lower physical functioning score on the SF-36 questionnaires.

Trudelle-Jackson and Smith (2004) conducted a study on the effects of an eight week home exercise programme during the late phase (4-12 months) of THA rehabilitation. Twenty eight THA patients were randomly assigned to either study group (14 subjects) or control group (14 subjects). Both groups underwent isometric and active range of movement exercises (gluteal muscle sets, quadriceps sets, hamstrings sets, ankle pumps, heel slides, hip abduction in supine, internal and external rotation in supine). The study group additionally underwent resistance exercises (sit-to-stand, unilateral heel raises, partial knee bends, one legged standing balance, knee raises with alternating arm raises, side and back leg raises in standing and unilateral pelvic raising and lowering in standing). Subjects in both groups were instructed to perform 15 repetitions of each exercise 3 to 4 times per week. The number of repetitions was gradually increased as the weeks progressed. 2 set of 20 repetitions were reached by the eight week. Muscle strength and postural stability were measured pre-training and post-training in both group while on a dynamometer and force platform respectively. The data collected at baseline and after the eighth week of the home programme are presented as follows.

Table 1. Muscle strength and postural stability in THA and Control groups

	Study group		control group	
Muscle strength (Nm)	pre-test	post-test	pre-test	post-test
Hip flexors	40.5	50.4	41.7	44.7
Hip extensors	53.0	78.4	52.1	54.0
Hip abductors	53.9	76.1	51.6	53.3
Knee extensors	76.6	94.5	68.8	69.5
Postural stability (%)	66.1	90.4	76.3	77.0

The data shows statistically significant improvement in muscle strength (i.e. hip flexors, 24.4%; hip extensors, 47.8% ; hip abductors, 41.2% and knee extensors, 23.4%) and postural stability (i.e. 36.8%) in the study group alone. This study shows the importance of incorporating resistance exercises in the late phase rehabilitation programme for THA patients.

Sashika et al. (1996) conducted a study to find out the effects of physical therapy on disabilities in patients with THA. The study design used was non randomised control trial incorporating home-based exercises. Twenty three subjects with mean age of 63.4 years and with 6-48 months post-THA surgery were recruited. They were divided into three groups. Group 1 (8 subjects) were given range of motion exercises of hip flexion and isometric muscle strengthening of low resistance to the hip abductors. Group 2 (8 subjects) was given same exercises as group 1 plus eccentric muscle contractile exercises of hip abductors in the standing position on one leg. Group 3 (7 subjects) serve as the control (no exercise was given). Group 1 and 2 carried out the exercises twice a day for 15-20 minutes for six weeks. Isometric torque of hip abductors was evaluated using isokinetic dynamometer machine at baseline and after six weeks. Walking speed and cadence were also evaluated with three dimension VICON motion analysis system.

The maximum isometric hip abduction torques improved significantly in the THA side from 13.4Nm to 16.6Nm in group 1, from 12.5Nm to 21.0Nm in group2, and from 9.1Nm to 13.6Nm in the control group. Group 2 had the greatest increase in hip abductor torque. Improvement in control group may be due to the effects of assessment on the dynamometer pre and post six weeks programme duration in which they have to contract their hip abductors maximally. Walking speed improved significantly from 60.1m/min to 63.6m/min in group 1, and from 64.4m/min to 69.0m/min in group 2 while it was not significant in group 3 (i.e. 57.4m/min to 58.7m/min). Cadence also improved significantly from 120.0steps/min to 126.8steps/min in group 1 and from 121.5steps/min to 131.3steps/min in group 2 but was not significant in group 3 (i.e. 117.4steps/min to 112.3steps/min). There was no statistically

significant improvement in cadence and walking speed in the control group. 70% compliance was also reported. Hence, home programme of isometric, eccentric and range of motion exercises was effective in improving hip abductor strength, walking speed and cadence in THA patients.

Jan et al. (2004) carried out a research into the effects of home programme on strength, walking speed, and function after THA. Fifty three THA subjects were randomly allocated to either study group (26 subjects) or control group (27 subjects). The study group underwent a twelve week daily home exercise comprising of the following exercises. Hip flexion range of motion exercises (2 sets by 10 repetitions/set), isotonic strengthening exercise for hip flexors, extensors and abductors with low resistance weight (1kg for women, 2kg for men) tied on the ankle (2 sets by 10 repetitions/set for each muscle group); additional strengthening of the hip abductors with 1-legged stance on each leg (2 sets by 10 repetitions/set, holding for 5s each repetition) and 30minute walk at a comfortable speed. An isokinetic dynamometer was used to measure muscle strength of hip extensors, flexors and abductors. Assessments were done Pre and post intervention. The study group data was divided into high compliance (greater than 50% compliance) and low compliance (lesser than 50% compliance) based on the number of days they did their home programme. Functional activity part of the Harris hip score was used to measure functional abilities of these patients.

Table 1.Muscle strength, walking speed and functional score THA and control groups

	Study group				control group	
	High compliance		low compliance			
	Pre	post	pre	post	pre	post
Muscle strength (Nm)						
THA side abductor	54.2	64.9	52.4	54.8	55.7	52.0
THA side flexors	49.2	57.5	48.9	48.4	54.2	50.8
THA extensors	70.1	79.6	72.0	70.5	74.8	72.5
Walking speed (m/min)						
Fast	85.0	98.6	88.5	89.7	85.8	81.0
Functional score	11.7	13.1	12.4	12.7	12.4	12.0

The data shows only statistically significant improvement in compliance high subgroup of the study group in hip flexor, extensor and abductor strength, fast walking speed on level surface and functional score of the Harris hip score. The low compliance group and the control group had similar measurement post intervention and this further demonstrate the impact of compliance with home-programme. Improvement in high compliance group is similar to group 2 of Sashika et al.(1996) study in which eccentric contraction and low resistance were done and also to the study group of Trudelle-Jackson and Smith (2004) in which resistance exercises. Improvement in hip abductor strength was greatest in Trudelle-Jackson and Smith (2004) study compared to Sashika et al.(1996) and Jan et al.(2004) and this may be due to the frequency of the intervention (i.e. two set of twenty repetitions of the intervention was reached at the end of the programme duration). This study revealed that home programme exercises were effective in improving the hip muscle strength when resistance exercises are included.

Conclusion:

Identification of the problems encountered by THA patients post surgery is vital for developing effective physiotherapy interventions. The problems commonly presented by THA patients post-op were decreased hip muscle strength, hip range of motion, walking velocity, stride length, cadence and increased double support time in stance phase of the gait cycle (Sliwinki et al., 2006; Sashika et al., 1996; Nallegowda et al., 2003; Jan et al., 2004; Trudelle-Jackson and Smith, 2004; Frost et al., 2006; Bertocci et al., 2004; Braeken et al., 1997). The decrease in THA walking velocity, cadence stride length and increase in their double support stance phase may be used to increase their balance while walking. Decrease in hip muscle strength was reported by most studies. Strength of the hip muscles has been shown to be an important predictor of walking speed and functional performance in patients with

THA (Hamadouche et al., 2001). Hence increasing hip muscle strength in THA patients may lead to increased gait parameters. Fiatrone and Evans (1993) have demonstrated that type 2A and 2B fibres which generates more force Than type 1 fibres during muscular contractions can be hypertrophied under high tension and fatigue inducing exercises. Hence, fatigue inducing active resistant exercises can be incorporated in late phase rehabilitation to increase their hip muscle strength (Jan et al., 2004; Sashika et al., 1996; Trudelle-Jackson and Smith, 2004). The frequency of outpatient visit which is often decreased in the late phase rehabilitation programme of most physiotherapy departments should be increased to achieve long term increase in THA hip muscle strength. Home programme should include active resistant exercises in the late phase. Home programme compliance as been shown to be vital in achieving increase in hip muscle strength should be encouraged in THA patients (Jan et al., 2004; Sashika et al., 1996). Physiotherapy as been effective in alleviating the problems associated with THA surgery in the late phase of rehabilitation as revealed by the various studies discussed above. Hence, physiotherapy should be intensified in the late phase rehabilitation programme for THA patients rather than decrease it as being done in most hospitals.

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