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Strength and Functional Deficits Following Total Hip Replacement in Individuals with Avascular Necrosis of Femoral Head

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Abstract

Background: AVN commonly affects femoral head causing pain, joint stiffness, muscle wasting and physical disability. THR, commonly done for AVN improves mobility, strength and physical functions by reducing pain and improving functions.

Methodology: Total 32 subjects, 16 age & gender matched healthy adults and 16 with AVN of femoral head were included. Muscle strength of hip muscles by modified sphygmomanometer, self reported Harris hip score and TUG test were taken preoperatively in subjects with AVN scheduled for a THR. All subjects underwent physiotherapy during hospital stay. Again all outcome measures were taken post hip replacement on the day of discharge. In healthy adults, only hip muscle strength was measured.

Results: 32 subjects, 28-males and 8-females. Mean age-36.88 years in both groups. Isometric muscle strength preoperatively in AVN subjects of hip flexors-76.75±50.67 mm of Hg, abductors-54.56±30.74 and extensor apparatus 75.38±37.32 was significantly reduced ($p<0.001$) compared to healthy adults,(hip flexors-188.42±15.69, abductors 112.67±21.66 and extensor apparatus-171.71±25.60). Postoperatively strength of hip flexors-93.12±52.58, abductors-63.62±33.74 and extensor apparatus-88.94±41.22 was reduced compared to healthy adults. Postop significant improvement ($p<0.05$) seen at discharge in strength compared to preop values.

Conclusion: Muscle strength of hip muscles in subjects with AVN preoperatively and post replacement was significantly reduced compared to normals. Postoperatively improvement was seen at discharge in strength compared to preoperative values.

Keywords: *Avascular necrosis, muscle strength, total hip replacement.*

Introduction

Avascular necrosis (AVN) also known as osteonecrosis, ischemic bone necrosis or aseptic necrosis is a disease that most commonly affects femoral head. [1,2,3] AVN occurs due to blood flow obstruction to the femoral head leading to death of bone-forming cells, bone tissue collapse and articular surface deformities.[4]

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Primary or idiopathic AVN occurs without any cause. Secondary AVN is seen in subjects with sickle cell anaemia, fracture or dislocation of hip, Gaucher's disease, excessive alcohol intake, and prolonged systemic steroid use in high doses.[2,5,6,7] Although initially the condition is painless, the subject's main complain is pain with limitation of motion. Pain is deep, intermittent and throbbing and is localized to the groin area. It exacerbates with weight bearing and relieves on rest. Joint deformity and muscle wasting may be present and it might present bilaterally.[1,8,9,10] Radiographically, AVN of femoral head has been classified by Ficat and Arlet into 4 stages as below: [11,12]

Stages	Features
Stage I	Normal imaging
Stage II	Normal femoral head contour, but with evidence of bone-remodeling, such as cystic or osteosclerotic regions.
Stage III	Evidence of subchondral collapse, or flattening of the femoral head
Stage IV	Narrowing of the joint space with secondary degenerative changes in the acetabulum, such as cysts, osteophytes, and cartilage destruction

Hip replacement is commonly undertaken to decrease pain and disability arising out of AVN of femoral head.[2,13] Most common surgical approaches for hip replacement are posterolateral, anterolateral and direct lateral.[14]

Hip replacement, depending on number of components, is of two types: Total hip replacement (THR) and hemi hip replacement. On the basis of the type of fixation of the implant it is either cemented or uncemented.

AVN causes physical disability whereas THR brings improvement in muscle strength and physical functions.[2,11,15,16,17] Thus this study aimed to see strength and functional deficits preoperatively and postoperatively in individuals with Avascular necrosis of femoral head.

Methodology

After getting approval from Sumandeep Vidyapeeth Institutional Ethical Committee, this observational study on subjects with AVN scheduled for THR, as well as healthy adults was carried out at Sumandeep Vidyapeeth affiliated Dhiraj general hospital, Piparia, Vadodara.

Males and females of ≥18years with avascular necrosis scheduled for THR were included in the study. Subjects with lower extremity orthopaedic pathology, hip osteoarthritis scheduled for replacement, neurological disorders that impaired daily functions were excluded from the study.

A total of 32 Subjects, 16 age and gender matched healthy adults as well as 16 with AVN of femoral head were recruited on the basis of inclusion and exclusion criteria. Those fulfilling the inclusion criteria and willing to participate signed a written informed consent. Patient information sheet given to the subjects explained the study. Subjects with AVN of femoral head (grades I-IV) were assessed preoperatively and postoperatively after undergoing hip replacement on the day of discharge. They were assessed for muscle strength of hip muscles, Timed up and go test and self-reported Harris Hip score. For muscle strength, the cuff of the sphygmomanometer was folded on the therapist's palm and inflated to a set pressure of 60mm of mercury (Hg). The therapist placed the cuff on the limb to be tested and asked the subject to perform the movement. The therapist applied resistance such that no movement occurred. The maximum reading was of 300mm of Hg. Subject was asked to perform 3 trials for each muscle strength. An average of 3 trials was considered for analysis.

Figure 1 – Modified sphygmomanometer

For hip flexors and hip abductors, the subject's position was supine lying. The cuff was positioned at distal thigh on the anterior aspect for resisting hip flexors and at distal thigh on the lateral aspect for hip abductors. The subject was asked to perform the movement and the therapist applied resistance such that no movement occurred.

Figure 2 – Method to measure strength of hip flexors

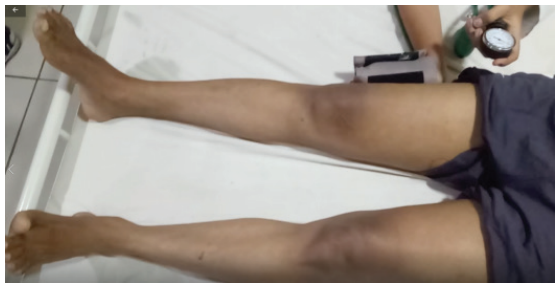

Figure 3 – Method to measure strength of hip abductors

For extensor apparatus, the subject's position was supine lying and the cuff was positioned under the heel. The subject was asked to press the heel down against the resistance of cuff.

Figure 4 – Method to measure strength of extensor apparatus

The Timed up and go test was performed as per standard protocol and self reported Harris hip score was taken on one-to-one basis. All the subjects received standard Physiotherapy program post hip replacement. Outcome measures were taken after hip replacement on the day of discharge. In healthy adults, only muscle strength was measured.

Statistical Analysis

Data was analysed with IBM- SPSS version 16.The data was normally distributed. Independent t-test was used to see the difference between the groups and paired t-test to see the difference within the groups. The level of significance was kept at $p<0.05$.

Results

Total subjects – 32

Subjects with AVN -16, 4 females and 14 males.

Age and gender matched healthy subjects - 16, 4 females and 14 males.

Table: 1 Comparison of hip muscle strength (mmHg) values in subjects with AVN and healthy adults.

Muscle strength (mmHg)	Group	N	Mean	Std. Deviation	Std. Error Mean	p-value
Hip flexors	Subjects with AVN	16	76.75	50.67	12.67	<0.001
	Normals	16	188.42	15.69	3.92	
Extensor apparatus	Subjects with AVN	16	75.38	37.32	9.33	<0.001
	Normals	16	171.71	25.60	6.40	
Hip abductors	Subjects with AVN	16	54.56	30.74	7.69	<0.001
	Normals	16	112.67	21.66	5.42	

Table: 2 Comparison of hip muscle strength (mmHg) values in subjects post THR at discharge and healthy adults.

Muscle strength (mmHg)	group	N	Mean	Std. Deviation	Std. Error Mean	p value
Hip flexors	Subjects with THR	16	93.12	52.58	13.15	<0.001
	Normals	16	188.42	15.69	3.92	
Extensor apparatuS	Subjects with THR	16	88.94	41.22	10.31	<0.001
	Normals	16	171.71	25.60	6.40	
Hip abductorS	Subjects with THR	16	63.62	33.74	8.44	<0.001
	Normals	16	112.67	21.66	5.42	

Table: 3 Comparison of hip muscle strength (mmHg) in subjects with AVN preoperatively and after THR.

Muscle strength (mmHg)	N	Mean	Std. Deviation	Std. Error Mean	P-value
Hip flexors pre op	16	76.75	50.67	12.67	0.017
Hip flexors post op	16	93.12	52.58	13.15	
Extensor apparatus pre op	16	75.38	37.32	9.33	0.004
Extensor apparatus post op	16	88.94	41.22	10.31	
Hip abductors pre op	16	54.56	30.74	7.69	0.015
Hip abductors post op	16	63.62	33.74	8.44	

The value of TUG test was 19.4±5.58 seconds preoperatively and 56.16±44.82 seconds postoperatively with p-value of 0.042.

Discussion

The present study tried to look at the strength and disability of subjects with AVN preoperatively and postoperatively on the day of discharge compared to healthy adults. In our study, 4 subjects had grade III AVN and 12 subjects had grade IV AVN. All subjects with AVN underwent uncemented THR: 6 were allowed weight bearing as tolerated, 2 were on non-weight bearing ambulation.

Isometric muscle strength of hip flexors, abductors and extensor apparatus in subjects with AVN preoperatively was 56.3% less compared to healthy adults. Two subjects with unilateral involvement were 29.5% weaker on affected side compared to unaffected side. Average NPRS on movement was 5.6 preoperatively which led to physical dysfunction and restricted weight bearing causing disuse atrophy.[15] Due to pain the subjects are inhibited and do not put their full effort during functions which reduces the muscle strength significantly compared to normals. Nazarov E. in 1989 found a direct correlation between the stages of the disease process and the degree of femoral muscular atrophy.[18]

Isometric muscle strength of hip muscles after total hip replacement in the same subjects was 48.04% less compared to normals. Muscle strength of hip abductors was maximally reduced. Similarly, studies have reported decrease in muscle groups associated with hip abduction, adduction, flexion and extension after THR. One of the reasons for this decrease could be 'arthrogenic muscle inhibition' which is the central nervous system's failure to activate muscles close to the operated hip joint due to intra-articular swelling, inflammation, pain, joint laxity or structural joint damage leading to atrophy of the muscles. [17,19]

In the present study, only 6 subjects were allowed weight bearing on first post-op day by the operating surgeons. Hip abductors and extensor apparatus are anti-gravity muscles. In non-weight bearing subjects, strength of hip abductors was 58.64 mm of Hg and 84.18 mm of Hg in extensor apparatus and in subjects who were weight bearing hip abductor strength was 71.8 mm of Hg and extensor apparatus was 96.85 mm of Hg. This decrease could be attributed to decreased muscle loading due to insufficient activity in the form of weight bearing exercises.[16] According to a study, adults with end-stage hip OA were 10–38% weaker in their arthritic lower extremity and performed 28–50% poorer on functional tests.[20] In our study, subjects with AVN were 56.3% weaker than normals and two subjects with unilateral involvement were 29.5% weaker than non-affected side. THR is generally done after AVN or hip OA in which muscle strength is already decreased preoperatively due to disease process.[11,15,18] So, after replacement, this reduced muscle strength takes time to recover.

Strength significantly improved post replacement on the day of discharge compared to preoperative status of AVN subjects. During hospital stay all of them performed strengthening and mobility exercises twice a day from first post-op day. In 6 subjects weight bearing as tolerated was begun on the first post-op day. This could have led to improvement in muscle strength after THR. The subjects received analgesics postoperatively. The average NPRS preoperatively was 5.6 on movement which reduced to 3.5 postoperatively at discharge which could also have led subjects to apply more effort during strengthening exercises. This increase in muscle strength in the initial post-op period is in agreement with several studies. [15,16,17,19,21]

In self reported HHS the component 'Support used' and 'distance walked' did not improve post surgery. Before THR, all the subjects were walking without support although with pain and limp and after surgery, only 6 were allowed weight bearing with frame, 2 were allowed non-weight bearing ambulation. There are conflicting studies available for weight bearing status in subjects with uncemented THR, where some studies support delayed weight bearing [22,23]and some support immediate weight bearing after surgery.[15,24,25,26] In our set up weight bearing was at the discretion of operating surgeon depending on bone quality and diameter of the medullary canal.

'Limp' probably improved/unobservable in subjects who were allowed for weight bearing post surgery as they were walking with a frame. Pre-op limp was present due to pain, muscle weakness and limb length discrepancy. All the subjects underwent a posterolateral approach which itself is associated with low rate of postoperative limp as the abductor muscles are not cut during surgery.[27] The subjects had reduced pain and improved strength post replacement due to which subject was able to bear weight on operated limb.

TUG test was assessed in 6 subjects who were allowed weight bearing. It increased considerably post-operatively as the subject was guarded/inhibited due to pain and took more time manoeuvring the walker. According to a study, walking with walker takes 30 seconds more time than walking with crutches.[28]

Conclusion

The muscle strength of hip flexors, abductors and extensor apparatus of subjects with AVN before and after surgery was significantly lesser as compared to normals. There was significant improvement in muscle strength of hip muscles post-surgery compared to pre-surgery.

A therapist should consider these results while formulating an exercise program and emphasize on strengthening of hip muscles both, in subjects with AVN and post hip replacement.

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