

FUNCTIONAL OUTCOMES OF HIP ARTHROSCOPY IN AN ACTIVE DUTY MILITARY POPULATION UTILIZING A CRITERION-BASED EARLY WEIGHT BEARING PROGRESSION

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ABSTRACT

Introduction: Hip arthroscopy allows surgeons to address intra-articular pathology of the hip while avoiding more invasive open surgical dislocation. However the post-operative rehabilitation protocols have varied greatly in the literature, with many having prolonged periods of limited motion and weight bearing.

Purpose: The purpose of this study was to describe a criterion-based early weight bearing protocol following hip arthroscopy and investigate functional outcomes in the subjects who were active duty military.

Methods: Active duty personnel undergoing hip arthroscopy for symptomatic femoroacetabular impingement were prospectively assessed in a controlled environment for the ability to incorporate early postoperative weight-bearing with the following criteria: no increased pain complaint with weight bearing and normalized gait pattern. Modified Harris Hip (HHS) and Hip Outcome score (HOS) were performed preoperatively and at six months post-op. Participants were progressed with a standard hip arthroscopy protocol. Hip flexion was limited to not exceed 90 degrees for the first three weeks post-op, with progression back to running beginning at three months. Final discharge was dependent upon the ability to run two miles at military specified pace and do a single leg broad jump within six inches of the contralateral leg without an increase in pain.

Results: Eleven participants met inclusion criteria over the study period. Crutch use was discontinued at an average of five days following surgery based on established weight bearing criteria. Only one participant required continued crutch use at 15 days. Participants' functional outcome was improved postoperatively, as demonstrated by significant increases in HOS and HHS. At the six month follow up, eight of 11 participants were able to take and complete a full Army Physical Fitness Test.

Conclusions: Following completion of the early weight bearing rehabilitation protocol, 81% of participants were able to progress to full weight bearing by four days post-operative, with normalized pain-free gait patterns. Active duty personnel utilizing an early weight bearing protocol following hip arthroscopy demonstrated significant functional improvement at six months.

Level of Evidence: Level 4, Case-series

Key words: Active-duty military, functional outcomes, hip arthroscopy, postoperative weight bearing

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INTRODUCTION

Hip arthroscopy has become a growing treatment option for femoracetabular impingement (FAI). Numerous authors have demonstrated that hip arthroscopy is a successful treatment modality with high rates of return to sport, as well as significant improvements in clinical and functional outcomes.¹⁻⁶ Additionally, it has been found to be a safe procedure with a low rate of major and minor complications, estimated at 0.58% and 7.5% respectively.¹

Rehabilitation following hip arthroscopy is integral to the clinical outcome.⁷ However, there is a vast disparity in the post-operative rehabilitation protocols reported through the literature,⁸ including weight bearing restriction,⁸⁻¹² brace use,¹³⁻¹⁵ and utilization of continuous passive motion machines^{5,13,14} with variations in these components according to specific procedures performed.⁸ Some of these restrictions are put in place to facilitate healing following surgery but others are related to early catastrophic complications, including femoral neck fractures and hip dislocations and instability,^{16,17} but all lack the support of high quality evidence.⁸

The purpose of this case series was to describe a criterion-based early weight bearing protocol following hip arthroscopy and investigate functional outcomes in the subjects who were active duty military. The authors hypothesized that weight bearing restrictions after hip arthroscopy can be counter-productive and may lead to post-operative sequelae including adhesion formation, hip flexor contractures, increased capsular tension with internal and external rotation, and altered gait patterns.

METHODS

Patients undergoing hip arthroscopy between May 2011 and June of 2012 for symptomatic FAI were prospectively evaluated. Inclusion criterion included active-duty personnel undergoing arthroscopic surgery for FAI treated with femoral neck osteochondroplasty, acetabuloplasty, labral repair or debridement, and/or fractional psoas lengthening who received postoperative therapy by a single physical therapist at the treating facility. Diagnosis of FAI was determined by one of two sports medicine fellowship trained orthopaedic surgeons upon assimilation of clinical exam and radiographic studies. Patients

were excluded from participation if they were not active military personnel or received therapy at another facility. Functional outcome measures were assessed using the modified Harris Hip score (HHS) and the Hip Outcome Score (HOS) preoperatively and re-administered six months following surgery.

All subjects were treated with a criterion-based early weight bearing progression post-operatively in controlled environments. Full weight bearing as tolerated was permitted immediately following surgery using bilateral crutch assistance with progression to full weight bearing facilitated according to the criteria presented in Table 1. Subjects self-restricted weight bearing with crutch assistance and were progressed to full, unassisted weight bearing through formal gait instruction, beginning with a step-to gait pattern, followed by step-through gait pattern with crutch assistance and progressing to unassisted gait as tolerated. A normalized gait pattern was identified as near symmetrical hip extension at toe-off when comparing the side of the surgical intervention to the non-involved side during visual gait analysis. Subjects were progressed with a standardized hip arthroscopy protocol, consisting of a four-phases progression. The protocol was standardized for all arthroscopic hip procedures, with no deviations determined by the type of surgical intervention (Appendix 1 and 2). Progression through the phases was dictated by to patient performance on weight bearing progression and time following surgery.

Phase I covers, on average, the first three weeks following surgery. During this time, subjects are allowed immediate weight-bearing as tolerated, discontinuing crutch use immediately if the patient achieves progression criteria presented in Table 1. Subjects are supervised through stretching exercises and non-resisted straight-leg raises and heel slides. They also begin stationary bike using slow revolution to emphasize hip motion. Hip flexion is limited to not exceed 90 degrees for the first three weeks post-op.

Once subjects have completed the weight bearing progression and have full passive motion with a non-antalgic gait, they are transitioned to Phase II for weeks 3-6 during which time strengthening exercises are added with proprioceptive exercises and treadmill walking. Running is restricted for the first

Table 1. Progressive weight bearing philosophy for rehabilitation following hip arthroscopy. Questions are designed to be answered by the treating therapist.

	Answering yes or no should be based over the past 2-3 days.	Yes/No
1	Is the patient's subjective pain report on the Visual Analog Scale decreasing? - No more than 2 point increase without crutches after a five step trial, unassisted	
2	Is the patient's use of narcotics decreasing?	
3	Is the patient's PROM increasing gradually following the procedures based upon protocols?	
4	Are the patient's uninterrupted sleeping habits gradually reaching normal for them? - The patient may increase full weight bearing in 1 hour long increments. - The patient may also be progressing from sleep destination (e.g. recliner to elevated postures in bed to supine)	
5	Is the patient tolerating the progression off of the crutches?	
6	*Is the patient compliant with procedure protocol precautions? - This is an absolute criterion. - If the patient is non-compliant and at risk of compromising the repair they are to stay on the crutches.	
*This criteria must be answered yes in order to progress. Of the first 5 criteria they must meet 4/5 to continue the progression.		

12 weeks. Subjects then progress to Phase III with more intensive proprioceptive and plyometric exercises with continued strengthening exercises aimed at restoration of symmetric muscular strength.

Phase IV begins at three months post operative, at which time a supervised walk-to-run program is implemented and subjects are allowed to begin sit-up and push-up training (two of the three criteria assessed as part of the Army Physical Fitness Test (APFT) with the third component consisting of a two mile run). At the completion of the four phase protocol, subjects are released from activity restrictions (US Army physical profile) and allowed to complete an APFT, a biannual requirement for all military personnel.

Statistical Methods

Demographic and functional outcome measures were recorded for all patients. Activity restrictions were identified by identifying the presence of a profile by cross-referencing the US Army Physical Disability Agency database to identify activity restrictions as related to training and completion of an APFT. The ability to pass an APFT was also recorded. Functional outcome scores, HHS and HOS, were compared before surgery and at final follow up with paired Students t-test with calculation of 95% confidence intervals. Statistical significance was predetermined as $p = 0.05$.

RESULTS

Sixty subjects were identified for participation during the study period. Of these, 19 subjects were excluded due to non-active military status, with an additional 30 subjects excluded for receiving there

therapy at another institution leaving 11 service members who met enrollment criteria. All 11 subjects underwent hip arthroscopy to address various subtypes of FAI and completed rehabilitation using the accelerated weight bearing rehabilitation protocol. Complete follow-up examinations were performed in 11/11 (100%) active duty soldiers and all subjects completed a full rehabilitation course. Average follow-up was six months and no subjects were lost to follow-up. In addition to diagnostic arthroscopy, post-operative procedures included labral debridement ($n = 3$), labral repair ($n = 7$), femoral neck osteochondroplasty ($n = 7$), and acetabuloplasty for pincer lesion ($n = 6$). Demographic data, pre-operative, and post-operative outcomes scores are listed in Table 2 and statistical analysis is summarized in Table 3.

Crutch use was discontinued at an average of five days following surgery based on established weight bearing criteria. Only one subjects required continued crutch use at 15 days. Mean preoperative HHS and HOS scores were 59.8 and 61.1 respectively. These measures improved to 94.1 (HHS) and 95.23 (HOS) at the six month visit. The mean improvement in HHS score was 34.3 and the mean improvement in HOS score was 34.2. Both outcomes had a an effect size > 3.3 , indicating a high overall impact of the surgery. There was a statistically significant difference ($p < 0.01$) comparing pre-operative and post-operative outcome scores for both the HHS and HOS questionnaires. In addition, the function in sport subscale of the HOS demonstrated similar results improving 37.1 points from 56.7 pre-operatively to 93.7 at the six month visit. This change was also found to be statistically significantly different ($p < 0.01$).

Table 2. Demographic, crutch use, and outcomes scores for patients undergoing hip arthroscopy.

Patient	Age (Years)	Gender	Days on Crutches	Pre HHS	Post HHS	Pre HOS	Post HOS	Pre Sport	Post Sport	Deployable?	APFT Restrictions
1	29	M	15	67.1	95.7	31.9	90.2	44.4	91.7	Yes	Run
2	38	F	5	45.1	71.5	55.6	95.8	42.2	91.7	Yes	Run
3	42	M	6	68.2	93.5	63.9	95.8	44.4	80.6	Yes	Run
4	36	M	4	68.2	100.0	67.7	97.0	62.5	96.9	Yes	None
5	27	F	5	67.1	95.7	73.6	97.2	68.9	96.9	Yes	None
6	32	M	2	52.8	100.0	45.8	95.8	44.4	91.7	Yes	None
7	32	M	4	37.4	95.7	72.2	95.8	68.9	96.9	Yes	None
8	38	F	5	68.2	95.7	70.8	93.1	68.9	96.9	Yes	None
9	23	M	5	67.1	95.7	48.6	97.2	62.5	96.9	Yes	None
10	29	M	3	63.8	95.7	80.6	94.4	59.4	96.9	Yes	None
11	43	M	2	52.8	95.7	61.1	95.2	56.7	93.7	Yes	None

Pre = Preoperative; HHS = Harris Hip Score; HOS = Hip Outcome Score; Post = Postoperative; Sport = Sports subsection of Hip Outcome Score; APFT = Army Physical Fitness Test

Postoperatively, all subjects were given activity restrictions, referred to as a physical profile in the military, limiting activity and military participation. At six months post-operatively, all subject's profiles were reviewed evaluating ongoing limitations. Three of 11 subjects (27%) had continued restriction with regard to performing the two-mile run event of the APFT. All other subjects (8/11) passed this event without restrictions. All subjects (11/11) completed the sit up and pushup events. All eleven service members were deemed deployable at the conclusion of the study period.

There were no reported complications including: infection, femoral neck fracture, dislocations, heterotopic ossification, avascular necrosis of the femoral head, or loss of fixation concerning labral repairs. No neurovascular injuries occurred during hip arthroscopy in this population.

DISCUSSION

Many existing protocols for rehabilitation after hip arthroscopy have comparable initial goals which include initial stretching exercises, ROM, and strength restrictions.^{8,11-14,18} Weight bearing status has considerable variation between surgeon and procedure, with some protocols restricting weight bearing during the first four to six weeks while others allow immediate weight-bearing for specific procedures.^{8,13,14,18} In this study, weight bearing is initiated in a controlled environments without crutches as early as the second day following surgery, regardless of the surgical procedure performed. Progression to full weight bearing was dictated by subject ability to pass the criterion described, as well as their tolerance and motivation. Requirements for transition to unprotected weight bearing included toleration to pain and near normal gait pattern. Subjects who

Table 3. Comparison of functional outcome score before and after surgery.

Variable	Mean	SD	t-value	Mean Difference	95% CI for Mean Difference	Effect Size	Power	p value
Pre HHS	59.80	10.97	14.69	34.28	27.19 to 41.37	3.61	1.00	<0.001*
Post HHS	94.08	7.74						
Pre HOS	61.07	14.42	54.73	34.16	24.94 to 43.38	3.32	1.00	<0.001*
Post HOS	95.23	2.07						
Pre Sport HOS	56.65	10.89	24.83	37.06	31.75 to 42.37	4.38	1.00	<0.001*
Post Sport HOS	93.71	4.95						
* Indicates statistically significant difference, $p < 0.05$								
Pre = Preoperative; HHS = Harris Hip Score; HOS = Hip Outcome Score; Post = Postoperative; Sport = Sports subsection of Hip Outcome Score; CI = Confidence Interval								

participated in this study had significantly improved HHS scores and HOS at six months, with minimal restriction on military duty. The outcomes of this study are comparable to previously reported studies with significant functional improvement as well as high return to sport/activity.^{4-7,13,14,18-20} This studies results suggest that accelerated weight bearing and early ROM can assist in attaining positive outcomes in terms of early improvements in rehabilitation while minimizing potential adverse effects, a concept that is supported in the literature.¹⁸ Likewise, there were no observed failures related to early weight bearing to include catastrophic failures such as femoral neck fracture or hip instability.

Limitations inherent to this study include the lack of a control group. Likewise, the sample size is small (inherent to a case series), limiting the ability to perform detailed subgroup analysis and the subject population does not reflect the general population, limiting its external validity. Although one therapist administered treatment and collected post-operative data, he was not blinded to study directives which

may have introduced bias. The US Army physical profile was also used to assess outcomes and many of the limitations placed upon a soldier are subjective according to the individual provider's assessment of function and physical abilities. Neither the Army physical profile or the APFT have been validated as outcomes measures but have been used in numerous previous studies as an adjunct for functional outcomes.^{2, 21-23} Deployment standards are also variable according to job description within the military. Additionally, no subject included in this study underwent a capsular closure. As such, the extrapolation of these results to subjects undergoing a capsular closure is limited.

CONCLUSIONS

In conclusion, the results of this case series support the implementation of early weight-bearing using a criterion-based protocol in a controlled setting for patients undergoing hip arthroscopy for symptomatic FAI. Future studies are needed to assess the long-term outcomes in active-duty patients treated with this protocol.

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Appendix 1. Overview of the Four Phase post-surgical hip arthroscopy rehabilitation protocol.

Phase 1 (Weeks 1-3)		Phase 2 (Weeks 3-6)	
Precautions	<ul style="list-style-type: none"> No running until 12 weeks (may begin walk to jog progression) WBAT with crutches. May DC crutches per weight bearing progression Watch for signs of infection May Shower after post op dressing removed by PT or Ortho (do not scrub over sutures or soak in bath) Prominent limping without crutches is discouraged No Sit-ups x 10 weeks 	Precautions	<ul style="list-style-type: none"> No running until 12 weeks (may begin walk to jog progression) WBAT with crutches. May DC crutches per DOR weight bearing progression Prominent limping without crutches is discouraged No Sit-ups x 10 weeks
Suggested Therapeutic Exercise	<ul style="list-style-type: none"> Recumbent/Stationary Bike Slow reps progressing to higher RPMs as tolerated Calf pumps, glute sets, Heel slides, HS sets, Quad sets (Estim as needed) FABER Stretch Prone press ups for bilateral hip flexor as patient tolerates may progress to isolated hip flexor stretching 4 way SLR with no resistance Limit Flex with Psoas release Limit ABD with ITB Release Pelvic Tilts anterior and posterior Weight shifting, heel raises 	Suggested Therapeutic Exercise	<ul style="list-style-type: none"> Continue Phase I exercises as needed Teach scar massage Stretches – HS, Hip Flexors (use prone →prone on elbows →prone press-ups if minimal pain) Step ups forward and lateral (2”→4”→6”) Leg press, progress to single leg (low weight, high reps in pain free ROM) HS Curls Squat progression (wall squat with ball → Squat machine) limit hip flexion to 90 degrees Proprioception Phase 1 Knee Fall outs in hook-lying Treadmill: forward and retro walking
Modalities	<ul style="list-style-type: none"> Ice 3-5 times daily for 20 minutes Other pain relieving modalities PRN (e.g. TENS) 	Modalities	<ul style="list-style-type: none"> Ice PRN
Cardiovascular Fitness	<ul style="list-style-type: none"> May do UBE 	Cardiovascular Fitness	<ul style="list-style-type: none"> May do stationary or recumbent bike at own pace
Education	<ul style="list-style-type: none"> Understand the need of compliance in rehabilitation, timelines, and goals Educate on sleep hygiene in recliner or supported with pillows. Review Precautions 	Education	<ul style="list-style-type: none"> Understand the need of compliance in rehabilitation, timelines, and goals Review Precautions
Rehabilitation Goals Progression Criteria	<ul style="list-style-type: none"> Pain and Effusion under control AROM 0-120 degrees hip flexion Good quad contraction, able to perform 10 SLR without lag or increased hip flexor pain Gait normal with (without) crutches 	Rehabilitation Goals Progression Criteria	<ul style="list-style-type: none"> AROM WFL (95% of asymptomatic contra lateral side) Up/down stairs WNL Walk 2 miles at 15 min/mile pace 10 Repetitive bilateral LE squats with 80-90% WB vs. asymptomatic contra lateral side (symmetrical)
Phase 3 (Weeks 6-10)		Phase 4 (Months 3-6)	
Precautions	<ul style="list-style-type: none"> No running until 12 weeks May begin walk to jog supervised in clinic at 10 weeks May Begin sit-up and pushups progression at 10 weeks 	Precautions	<ul style="list-style-type: none"> May Run independently if tolerates walk to jog progression in clinic x 3 months post-operative No contact sports x 6 months May Begin sit-up and pushups progression at 10 weeks
Suggested Therapeutic Exercise	<ul style="list-style-type: none"> Continue Phase II exercises as needed Plyometric Phase 1-2 Proprioception Phase 2-3 Assisted isolated hip flexor stretching May require Piriformis stretching Super Set for HS and Quads: Total Of 3 Sets With Muscle Failure At 1st Set Of 20 Reps. Standing Hip 4 way Passive FABER Stretch in supine May introduce core stabilization 	Suggested Therapeutic Exercise	<ul style="list-style-type: none"> Continue Phase III exercises as needed Plyometric Phase 2-3 Proprioception Phase 3 Sport Specific Training May introduce core stabilization

Appendix 1. (continued) Overview of the Four Phase post-surgical hip arthroscopy rehabilitation protocol.

Modalities	<ul style="list-style-type: none"> Ice PRN 	Modalities	<ul style="list-style-type: none"> Ice PRN
Cardiovascular Fitness	<ul style="list-style-type: none"> May do stationary or recumbent bike at own pace May use elliptical to tolerance 	Cardiovascular Fitness	<ul style="list-style-type: none"> Begin walk to jog May use elliptical
Education	<ul style="list-style-type: none"> Understand the need of compliance in rehabilitation, timelines, and goals 	Education	<ul style="list-style-type: none"> Understand the need of compliance in rehabilitation, timelines, and goals
Rehabilitation Goals Progression Criteria	<ul style="list-style-type: none"> AROM Symmetrical Hip Strength 4+-5/5 Single leg squat (at 60° knee flexion) and hold symmetrical to asymptomatic contra lateral side. 10 Repetitive bilateral LE squats with 80-90% WB vs. asymptomatic contra lateral side (symmetrical) 	Rehabilitation Goals Progression Criteria	<ul style="list-style-type: none"> Single leg hop for distance (95% of asymptomatic contra lateral leg) Triple Single leg hop for distance (95% of asymptomatic contra lateral leg) Pass APFT all Events

Appendix 2. Plyometric and proprioceptive exercises performed during the various phases of the post-surgical hip arthroscopy protocol.

Lower Extremity Plyometric Exercises		
Phase 1	Phase 2	Phase 3
Quick Feet: 15-30 Sec x 3 sets -Laterals, V's, Toe Taps	Quick Feet: 30-60 sec x 3 sets -Laterals, V's, Toe Taps, switch stances	Quick Feet: 60 sec x 3 sets -Laterals, V's, Toe Taps, switch stances (Single leg pauses and jumps)
Light Cariocas	Cariocas and Tapiocas	Shuttle Runs: Cariocas/tapiocas incorporated into cone drills with direction changes.
Light Ladder Drills: forward and lateral	Ladder Drills: diagonals with single leg pauses (Heisman's, skips, etc.)	Ladder Drills: Single leg (entire drill on involved and uninvolved)
Box Jumps: Low-Med (eccentric Landing with Hip ER moment) with emphasis on preventing medial knee collapse.	Box Jumps: All Level (up and down repetitive jumps over multiple boxes)	Box Jumps: Medium --> High with squat jumps with continuous effort to fatigue.
Cone Drills: Short (<1ft apart) with double leg forward directions	Cone Drills: Short - Medium (2-3ft apart) Double leg, progressing towards single leg landing.	Cone Drills: Distance to challenge patient's ability. Single leg broad jump progressing towards triple.
Lower Extremity Proprioception Exercises		
Phase 1	Phase 2	Phase 3
Single Leg Stance: 15-45 seconds level surfaces progress to unstable	Single Leg Stance: 30-60 seconds uneven surfaces	Single Leg Stance: Unstable surfaces (foam mat) with perturbation
Trampoline: Double leg hopping for time progressing from 15-45 seconds	Trampoline: Double --> Jogging in place for time.	Trampoline: Single leg hopping for repetitions in a minute.
Fitter Board: Fitter with UE support to no support (light resistance)	Fitter Board: Medium Resistance (timed for repetitions in a minute)	Fitter Board: High resistance (timed for repetitions in a minute)
Lunges: Static Lunges to dynamic single stepping on stable surfaces.	Lunges: Dynamic from stable surfaces to unstable (floor --> BOSU, may add medicine ball)	Lunges: Dynamic onto unstable surfaces (e.g. on BOSU ball and stepping onto another BOSU ball)