Functional Outcomes of Hip Arthroplasty in Active Duty Military Service Members

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There are few reports on outcomes after hip arthroplasty in the military population despite increases among young, active patients. U.S. Army service members with coded hip arthroplasty between 2004 and 2010 were reviewed. Patient demographic variables were correlated with occupational outcomes. Of 183 patients, the occupational outcomes at a minimum 2 years postoperatively for service members undergoing primary hip arthroplasty were medically separated (n = 44, 24%), retired (n = 82, 45%), and returned to active duty (n = 57, 31%). Multivariate analysis identified that age less than 40 years [odds ratio (OR), 3.41; 95% confidence interval (CI), 1.14, 10.12] and enlisted rank (OR, 3.63; 95% CI, 1.29, 10.20) as major independent risk factors for medical separation. Univariate analysis revealed that officer rank had an increased likelihood of postoperative combat deployment than enlisted rank (OR, 3.39; 95% CI, 1.50, 7.94). Despite encouraging results in the civilian literature, this study documents modest retention rates on active duty at a minimum of 2 years after primary hip arthroplasty. (Journal of Surgical Orthopaedic Advances 22(1):16–22, 2013)

Key words: functional outcome, hip arthroplasty, military, occupational, physical activity

With over 200,000 procedures performed annually in the United States, hip arthroplasty has revolutionized the management of arthritic and other pathologic conditions affecting the hip while dramatically improving pain and function (1). In response to expanding indications, the utilization of hip arthroplasty has continued to rise sharply as well (2), particularly among young, active cohorts (3). Yet, Although total hip arthroplasty (THA) has reproducible results in elderly patients, insufficient clinical data exist for younger patient populations in their return to function and ultimate clinical and occupational outcome. Some authors have demonstrated reasonable outcomes with younger patient age (<55 years), with implant survivorship ranging from 85% to 94% at 10-year follow-up (4–6).

The overall incidence rate of primary hip osteoarthritis in U.S. Army service members has been reported to be 43.3 per 100,000 person-years, which is significant considering that the average age of U.S. Army service members is 29 years old (7). Active patients who have been exposed to high physical demands during sports and work activities have a significantly increased relative risk for developing primary hip osteoarthritis [men 8.5: 95% confidence interval (CI), 4.0, 17.9; and women 4.3: 95% CI, 1.1, 11.0] than their lower demand counterparts (8, 9).

The U.S. Army represents a physically active population of both male and female service members with generally high occupational demands. These service members regularly take part in both individual and group physical fitness training programs. Semiannually, U.S. Army service members must meet height and weight requirements as well as the Army Physical Fitness Test standards as measured by three events: timed 2-minute push-up, 2-minute sit-up, and aerobic event (e.g., timed 2-mile run or $2\frac{1}{2}$-mile walk). Additionally, standard training for active duty military service members involves intensive military occupational specialty training and the physical capacity to perform up to a 12-month combat deployment in an austere environment. If a service member is unable to successfully complete these mandatory requirements, a military medical discharge is initiated.

Two prior small case series have examined surgical outcomes of primary THA within the high-demand, physically active military population during periods of relative peace in U.S. history (10, 11). The purpose of this study is to assess military service member active duty retention and combat deployment rates after a primary THA or hip resurfacing arthroplasty (HRA) during the conflicts in Iraq

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TABLE 1 Functional outcomes of active duty service members after hip arthroplasty

	THA/HRA (*n*)	Medical Separation (%)	Retired (%)	Active Duty No Deployment (%)	Active Duty Combat Deployment (%)
Sex					
Male	166	40 (24%)	73 (44%)	29 (17%)	24 (14%)
Female	17	4 (24%)	9 (53%)	2 (12%)	2 (12%)
Rank					
E1-E9	123	39 (32%)	56 (46%)	17 (14%)	11 (9%)
WO1-WO5/O1-O9	60	5 (8%)	26 (43%)	14 (23%)	15 (25%)
Age					
<40	45	20 (44%)	13 (29%)	7 (16%)	5 (11%)
40–49	92	18 (20%)	42 (46%)	16 (17%)	16 (17%)
≥50	46	6 (13%)	27 (59%)	8 (17%)	5 (11%)
Deployment history					
Yes	108	26 (2%4)	40 (37%)	24 (22%)	18 (17%)
No	75	18 (24%)	42 (56%)	7 (9%)	8 (11%)
Total	183	44	82	31	26

THA/HRA, total hip and hip resurfacing arthroplasty.

and Afghanistan. We hypothesized that both younger age and enlisted rank in those service members with a primary THA or HRA are associated with decreased active duty retention and combat deployment rates secondary to their rigorous occupational demands.

Methods

The United States Army Southern Regional Medical Command in San Antonio, Texas, maintains a database of U.S. Army active duty service members organized by Current Procedural Terminology (CPT) code. This database was queried for all instances of primary total hip arthroplasty and hip resurfacing arthroplasty, as designated collectively by CPT code 27130, between the calendar years 2004 and 2010. The U.S. military electronic medical records system, the Armed Forces Health Longitudinal Technology Application (AHLTA), was searched for each service member previously identified to confirm accurate coding and the occurrence of a primary THA or HRA during the study period. Demographic information including sex, rank, age, and history of combat deployment was recorded and cross-referenced for accuracy for all service members undergoing a primary THA or HRA. Rank was organized by enlisted (noncommissioned; E1–E9) and officer (warrant and commissioned; WO1–WO5/O1–O6), while age categories included <40 years, 40 to 49 years, and ≥50 years. Additionally, service members who performed combat deployment after primary THA or HRA were isolated for further extensive review, including evaluation by surgical indication or underlying hip condition (e.g., osteoarthritis,

TABLE 2 Univariate analysis evaluating risk factors for medical separation after hip arthroplasty

	THA/HRA (*n*)	Medically Separated (*n*)	Not Medically Separated (%)	Odds Ratio (95% CI)	*p* Value
Sex					
Male	166	40 (24%)	126 (76%)	1.032 (0.318–3.334)	.9587
Female	17	4 (24%)	13 (76%)	Referent	
Rank					
E1-E9	123	39 (32%)	84 (68%)	5.107 (1.896–13.760)	.0013
WO1-WO5/O1-O9	60	5 (8%)	55 (92%)	Referent	
Age					
< 40	45	20 (44%)	25 (56%)	5.333 (1.885–15.092)	.0013
40–49	92	18 (20%)	74 (80%)	1.622 (0.596–4.411)	.3438
≥50	46	6 (13%)	40 (87%)	Referent	
Deployment history					
Yes (1+)	108	26 (2%4)	82 (76%)	1.004 (0.504–2.001)	.9908
No (0)	75	18 (24%)	57 (76%)	Referent	
Total	183	44		139	

THA/HRA, total hip and hip resurfacing arthroplasty.
Not Medically Separated includes the following: active duty no deployment, active duty combat deployment, retired.

TABLE 3 Univariate analysis evaluating prognostic factors for deployment after hip arthroplasty

	THA/HRA (*n*)	Active Duty Combat Deployment (%)	No Postoperative Combat Deployment (%)	Odds Ratio (95% CI)	*p* Value
Sex					
Male	166	24 (14%)	142 (86%)	1.267 (0.272–5.88)	.7625
Female	17	2 (12%)	15 (88%)	Referent	
Rank					
E1-E9	123	11 (9%)	112 (91%)	Referent	
WO1-WO5/O1-O9	60	15 (25%)	45 (75%)	3.390 (1.449–7.937)	.0049
Age					
< 40	45	5 (11%)	40 (89%)	1.025 (0.275–3.814)	.6503
40–49	92	16 (17%)	76 (83%)	1.726(0.590–5.051)	.2184
≥50	46	5 (11%)	41 (89%)	Referent	
Deployment history					
Yes (1+)	108	18 (17%)	90 (83%)	1.675 (0.687–4.082)	.2564
No (0)	75	8 (11%)	67 (89%)	Referent	
Total	183	26	157		

THA/HRA, total hip and hip resurfacing arthroplasty.
No Postoperative Combat Deployment Includes the following: medically separated, retired, active duty no deployment.

osteonecrosis, dysplasia). The Pentagon Defense Manpower Data Center database was queried to ascertain the deployment start and end dates for each identified service member, and deployments before or after the service member's primary THA or HRA were recorded. All Army service members are required to meet standards of medical fitness published in Army Regulation 40-501 (Headquarters, Department of the Army, Washington, D.C.). Army Regulation 40-501 specifically defines the functional abilities required of Army service members in order to deploy. The functional ability of every Army service member is tracked on a standardized form (DA 3349) that is updated after treatments by health care providers. The Army's Medical Protection System Office tracks functional abilities as documented by health care providers and records each service member's deployability status. Both the U.S. Army's Medical Protection System and AHLTA military electronic medical records system were searched for any medical separation actions regarding each service member in the cohort. Military occupational outcomes were categorized as medical separation, retired, active duty no deployment, and active duty combat deployment.

Univariate analysis for association between independent patient demographic variables and the outcomes of a service member being medically separated and performing a combat deployment were performed using logistic regression. A controlled weighted regression model was subsequently constructed using all independent variables that demonstrated a p value $<.2$ in univariate testing. The controlled analysis consisted of weighted logistic regression with multiple predictors for occupational outcomes. Controlled weighted analysis resulted in p value, OR, and 95% CI for each independent predictor variable. All calculations were performed using SAS software, version 9.2 (SAS Institute, Cary, NC).

Results

There were a total of 183 primary hip arthroplasty procedures, including 177 THAs and 6 HRAs, identified in active duty U.S. Army service members between the calendar years 2004 and 2010. All surgeries were performed at tri-service military medical centers or civilian medical centers within the United States by military surgeons. The average age of the patients in this study at the time of primary THA or HRA was 44.6 (SD 8.0; range, 18.9–62.2) years old. The majority of patients were male (91%) and enlisted rank (67%), who had a previous combat deployment (59%) and were in the 40- to 49-year age group (50%). The service members were followed for an average of 4.4 (SD 1.5; range, 2.0–8.3) years.

The occupational outcome at a minimum 2 years postoperatively for service members undergoing a primary THA or HRA were medically separated (24%), retired (45%), and returned to active duty (31%) (Table 1). All medical separations were initiated within 3 years of surgery, with the exception of two senior officers who underwent medical separation at 4 years after surgery. Eighty-two service members with a primary THA or HRA already had or were able to return to active duty until they had the minimum 20 years of military service to retire.

Univariate testing identified significant demographic risk factors for a service member being medically separated from active duty following a primary THA or HRA (Table 2). Compared with the officer group, the enlisted service members had a significantly increased odds ratio for being medically separated of 5.11 (95% CI, 1.90, 13.8). Compared with the ≥50 years age group as the referent category, the <40 years age group had an increased odds ratios for being medically separated: OR, 5.33 (95% CI, 1.89, 15.1). The demographic variables of

sex and previous history of combat deployment were not associated with a service member being medically separated.

Multivariate logistic regression analysis identified significant risk factors for a service member being medically separated from active duty following a primary THA or HRA. Multivariate logistic regression analysis identified the enlisted rank group (OR, 3.63; 95% CI, 1.29, 10.20) and the <40 years age group (OR, 3.41; 95% CI, 1.14, 10.12) as major independent risk factors for being medically separated.

Univariate testing identified significant demographic variables for a service member serving a combat deployment following a primary THA or HRA (Table 3). Compared with the enlisted rank group, the officer rank group had a significantly increased odds ratio for serving a postoperative combat deployment of 3.39 (95% CI, 1.50, 7.94). The demographic variables of sex, age, and previous history of combat deployment were not associated with a service member performing a postoperative combat deployment. The Appendix contains pertinent demographic information and clinical course for all service members who performed a combat deployment after a primary THA or HRA.

Discussion

In the current study, we document modest returns to military duty among active duty Army service members after total hip arthroplasty or resurfacing. At 2- to 8-year follow-up, 31% of service members resumed military service, but only 14% of the total served a postoperative combat deployment. Additionally, over 24% of service members after a primary THA or HRA were medically separated secondary to limitations attributable to the hip arthroplasty surgery.

Prior characterizations of outcomes after hip arthroplasty in military service members are limited to two small series. At an average 4-year follow-up, Kuklo and colleagues (10) reported that 18 of 27 soldiers (67%) returned to active duty after hip arthroplasty with a mean Harris Hip Score of 93. In a separate evaluation of U.S. Army aviators, 7 of 11 service members (64%) returned to flight duty (11). Similar to these studies, younger chronological age and enlised rank were predictive of medical discharge in our military cohort, whereas no differences were attributable to sex.

However, these results underscore the differences of prior reports in the civilian literature that report that individuals are often able to return to moderate physical activity compared to the rigorous physical training and military occupational specialty training requirements of U.S. Army soldiers. Williams et al. (12) demonstrated that male sex, preoperative UCLA activity score, younger age, and body mass index (BMI) were independently associated with return to at least a moderate level of activity (i.e., UCLA score >6) at 1 year postoperatively after THA, while surgical procedure and implant bearing surface failed to demonstrate any statistical significance. Similarly, several studies also confirm higher levels of activity among male cohorts after hip arthroplasty (13–17), while Delasotta et al. (18) demonstrated no difference among young cohorts. Schmidutz and colleagues (19) offered a more nuanced perspective, indicating that men undergoing THA were more likely to be involved in intermediate- and high-impact sporting activity preoperatively and thus demonstrated a greater transition toward lower intensity athletic involvement after surgery.

For many studies, younger age has served as a proxy for higher levels of activity (12, 13, 15, 17), although some authors dispute this trend. Schmidutz et al. (19) demonstrate no difference in patient-reported outcomes or return to activity by age above or below 55. Naal et al. (20) showed that older cohorts (>55 years) actually demonstrated greater frequency and duration of athletic involvement and fewer reports of hip pain or limited range of motion after HRA. Similarly, in the current study, multivariate analysis found that those service members in the ≥50 years age group compared to the <40 years age group were threefold more likely to not be medically separated after primary THA or HRA.

Level of preoperative activity and occupational demands are relevant factors in determining postoperative function. The current study showed that service members with a prior deployment history were not more likely to deploy or return to military duty after hip arthroplasty. Several authors have correlated preoperative UCLA activity score (a validated, normative measure of physical activity in hip arthroplasty patients) with postoperative levels of function both in an athletic and occupational capacity (12, 21). Nunley et al. (21) demonstrated that individuals with moderate or greater preoperative levels of activity (UCLA score >5) reliably returned to "heavy" or "very heavy" demand jobs, with only 3.2% of patients reporting a permanent work restriction after surgery. Furthermore, individuals with the highest UCLA scores performed squatting activities with greater ease and less pain (21). Conversely, at a minimum of 2-year follow-up, only 31% of active duty service members remained on active duty after primary THA or HRA, highlighting the disparity in occupational demands among military and civilian cohorts.

However, certain surgeons have advocated for extensive patient education and consideration of activity modification after arthroplasty, particularly with sporting and high-impact activities (22–24). Despite return to sports in 52% to 98% of patients (13, 17, 19, 20), several authors

strongly recommend certain postoperative limitations on the frequency, intensity, and nature of physical activity, largely because of concerns for higher linear wear rates (14), aseptic loosening (25, 26), secondary revision rate (25, 27), and potential periprosthetic fracture or dislocation (18, 28) with prolonged at-risk exposure. However, Dubs et al. (26) have argued that routine, low-impact exercise stimulates protective bone remodeling, while potentially enhancing biologic ongrowth. Mont and colleagues (29) have also shown that active athletes satisfactorily return to play without subjective complaints at 8-year evaluation. With the increasing patient focus on resumption of physical activity after THA and improved wear characteristics with cross-linked polyethylene liners (30), further long-term studies are required to better articulate specific activities contributing to accelerated joint wear and the interval to symptomatic presentation.

Although hip arthroplasty does lead to predictable return to function, active cohorts may still experience limitations and activity-related symptoms (16, 18–20). In his young, active patient population, Delasotta et al. (18) noted a 83.3% and 450% decrease in "occasionally" permitted and discouraged activities, respectively, in large because of concerns for subsequent injury (29%), physical recommendation (26%), or diminished interest (14%). However, despite nearly universal satisfaction with their function, a significant subset of patients complained of persistent hip pain (14%), early fatigue with activity (17%), or pain in one or more joints other than the hip (one joint, 25%; two or more, 19.4%) after THA (18). Other authors have also shown the preponderance of self-imposed activity limitations in athletic patients undergoing hip arthroplasty, although activity-related symptoms can occur in 10% to 30% and may be increased with younger patient age (10, 16, 19, 20). Preoperative discussion and consideration of these potential outcomes are of importance for our military service members.

Given the retrospective nature of this study and its unique study demographic, the authors acknowledge certain limitations of this study. The patient population represents an active cohort with largely nonmodifiable physical demands inherent to military service. As active duty service members, these patients may be authorized to participate in alternate, lower-impact exercise during routine aerobic physical training. They are still all required to perform core military functions on a daily basis, including the ability to to march 2 miles with 40 additional pounds of gear, specialized field exercises, wearing individual body armor, and evasion of direct and indirect fire in an austere combat environment. Although the current consensus guidelines espoused by the American Association of Hip and Knee Surgeons and Hip Society do not explicitly address these activites, many military-specific tasks are likely incompatible with hip arthroplasty (23). None of the 26 patients who deployed required specialized care in theater; nonetheless, medical facilities may be ill-equipped to address potential complications during postoperative deployment. The rationale for return to duty was often inaccessible. Factors such as surgical indication, BMI, military occupation, implant bearing surface and design, postoperative rehabilitation protocol, and issues related to secondary gain were unable to be evaluated, which may introduce confounding in the current study.

Despite these limitations, this study is the largest evaluation of hip arthroplasty outcomes in active duty military service members and the first to examine the ability of service members to perform a postoperative combat deployment. In this series, approximately one-third of patients remained on active duty at a minimum of 2 years after primary THA or HRA. As a military community, we must formally establish consensus guidelines and recommendations on return to duty after arthroplasty. We should also identify means of further optimizing patient function without compromising long-term outcomes after arthroplasty in active patient populations.

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APPENDIX 1 Demographics and clinical course of military service members performing a combat deployment after hip arthroplasty

	Age	Sex	Rank Group	Prior Deployments	Diagnosis	Procedure	Reoperation	Complications	Problems During Deployment
1	43	M	Officer	0	OA	THA	Two-stage revision total hip arthroplasty	Stiffness, anterior pain, prosthetic infection diagnosed after deployment	Subcutaneous abscess drained during deployment
2	51	M	Officer	4	OA	THA	None	None	None
3	29	F	Enlisted	1	OA	THA	None	Pain	Hip pain treated with NSAIDS
4	46	M	Officer	1	OA	THA	None	None	None
5	36	M	Officer	3	OA	HRA	None	None	None
6	51	M	Enlisted	0	OA	THA	None	None	None
7	45	M	Enlisted	2	OA	THA	None	Pain	Multiple clinic visits for pain medication
8	23	M	Enlisted	0	Osteonecrosis	THA	None	None	None
9	47	M	Officer	0	OA	THA	None	None	None
10	41	F	Enlisted	1	OA	THA	None	None	None
11	48	M	Officer	0	OA	THA	None	None	None
12	35	M	Officer	1	Osteonecrosis	THA	None	None	None
13	39	M	Officer	2	Osteonecrosis	HRA	None	None	None
14	46	M	Enlisted	1	Osteonecrosis	THA	None	None	None
15	53	M	Officer	1	OA	THA	None	None	None
16	47	M	Officer	2	OA	THA	None	Occasional hip pain	Pain
17	45	M	Enlisted	2	OA	THA	None	None	None
18	47	M	Enlisted	2	OA	THA	None	None	None
19	51	M	Enlisted	1	OA	THA	None	None	None
20	41	M	Enlisted	2	OA	THA	None	None	None
21	49	M	Warrant	1	OA	THA	None	None	None
22	43	M	Officer	0	OA	HRA	None	None	Pain after 10-km run
23	42	M	Officer	0	OA	HRA	None	None	None
24	49	M	Officer	0	OA	THA	None	None	None
25	41	M	Enlisted	2	OA	THA	None	None	None
26	58	M	Officer	2	OA	THA	None	None	None

M, male; F, female; OA, osteoarthritis; THA, total hip arthroplasty; HRA, hip resurfacing arthroplasty; NSAIDS, nonsteroidal anti-inflammatory drugs.