Original Article

Impact of Sling Use on Functional Mobility in a Geriatric Population

Sudarsan Murali, MD, MBA[1]; Mathew Hargreaves, BS[3]; Kyle Paul, MD[2]; John N. Manfredi, BS[3]; Jun Kit He, MD[3]; Sean Young, DO[3]; Marshall Williams, MD[4]; Eugene Brabston, MD[3]; Brent Ponce, MD[4]; and Amit Momaya, MD[3]

Objectives: Sling immobilization is commonly used following rotator cuff repair. The purpose of this study was to determine the detrimental impact of sling usage on mobility and balance in an older adult population through validated gait and balance testing. The authors hypothesize that sling use will negatively affect balance and stability.

Methods: This institutional review board–approved and registered randomized prospective clinical trial enrolled patients from 2019 to 2021. Following informed consent, patients were randomized into two groups: a sling worn (group 1) and no sling worn (group 2). Participants were assessed via the Edmonton Frail Scale as well as Tinetti gait and balance scoring.

Results: Fifty patients were included in the study, 23 (46%) men and 27 (54%) women, with a mean age of 72.2 years. The balance score median was 16.00 for participants not wearing a sling and 15.00 for participants wearing a sling. The gait score median was 12.00 for participants not wearing a sling and 11.50 for participants wearing a sling. The balance and gait scores were significantly greater when patients were not wearing a shoulder sling with P values of 0.006 and 0.011, respectively. The overall combined gait and balance score was significantly greater, with median values of 27.00 for participants not wearing a sling and 26.00 for participants wearing a sling ($P = 0.001$). Patients reported little to no anxiety about falling while wearing the sling, with a score of 0.16.

Conclusions: Postoperative sling immobilization negatively affects balance and gait in the geriatric population, potentially increasing the risk of postoperative falls in an already at-risk population.

Key Words: geriatrics, mobility, orthopedic surgery, shoulder arthroplasty, sling

From the [1]Department of Orthopaedic Surgery, Johns Hopkins University, Baltimore, Maryland, the [2]Department of Orthopaedic Surgery, UT Health San Antonio, San Antonio, Texas, the [3]Department of Orthopaedic Surgery, University of Alabama at Birmingham, Birmingham, Alabama, and the [4]Department of Orthopaedic Surgery, Hughston Clinic, Columbus, Georgia.

Correspondence to Dr Amit Momaya, Department of Orthopaedic Surgery, University of Alabama at Birmingham, 1313 13th St, Birmingham, AL 35205. E-mail: amomaya@uabmc.edu. To purchase a single copy of this article, visit sma.org/smj. To purchase larger reprint quantities, please contact reprintsolutions@wolterskluwer.com.

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Sling immobilization is used commonly following rotator cuff repair, shoulder arthroplasty, and proximal humerus fracture treatment, all of which are more common in the older adult population.[1] Postoperatively, patients frequently wear bulky slings known as shoulder abduction braces (SABs) with non-weight-bearing restrictions for several weeks for comfort and to facilitate healing.[2–4] Although shoulder immobilization following surgery and fracture care is common practice, current rehabilitation recommendations have considerable variation based on surgeon preference.[5] Prolonged shoulder immobilization is associated with muscular atrophy, joint adhesions, and tendon degradation, as well as other potential adverse sling-related effects, including pain, functional limitations, and patient frustration.[4–8]

Factors such as lower limb dysfunction, mental impairment, and the material environment are associated with increased incidence of postoperative falls in the older adult population.[9] Functional compromise of the upper extremity also has been shown to be associated with an increased fall risk in the older adult population.[10,11] The use of shoulder immobilizers has been shown to negatively affect balance scores in older adult patients.[12] The use of an upper extremity sling alters the natural arm swing, which plays a role in maintaining balance and gait stability.[13–15] As such, limiting natural arm movement likely increases the risk of falls, especially in frail patients. Preliminary studies have associated sling use with a heightened fall risk of 13.8% following rotator cuff repair.[16] Postoperative falls can be detrimental to recovery, increasing the risk of both shoulder and overall morbidity and mortality.[16] Targeted therapies for gait and balance training and early motion protocols are rarely prescribed in this setting, however.

The effects of shoulder immobilization with an SAB have not been extensively studied in the literature to date, particularly in the context of a prospective randomized trial. The purpose of

Key Points

- The use of shoulder abductor braces negatively affects balance and gait, which potentially increases the risk of postoperative falls in the older adult population.
- Clinicians should scrutinize shoulder abductor brace usage in geriatric patients and balance the need for comfort and tissue healing versus the risk of falls.

the present study was to determine the degree of impact of sling usage on mobility and balance in an older adult population through validated gait and balance testing. The authors hypothesize that sling use will negatively affect balance and stability.

Methods

Study Design

Following institutional review board approval and registration with ClinicalTrials.gov (NCT03921619), the authors prospectively randomized a series of patients being seen at the orthopaedic hand clinic during a 2-year period (2019–2021). The inclusion criterion for the study was age older than 65 years. Patients were excluded for a history of shoulder surgical interventions within the past year, concomitant symptomatic joint disease, extremity injury, neuromotor deficits, cognitive impairment, and current use of a shoulder sling or assistive walking devices such as crutches, canes, or walkers for any reason. Despite this, patients who did have some self-reported difficulty in walking were included in this study as long as they did not require any walking devices so we could capture the full population that may be affected by sling use. In all, 50 patients were included in the study. This number was chosen based upon the feasibility of recruitment in the home institution's orthopaedic hand clinic. Following informed consent, patients were randomized into two groups: a sling worn (group 1) and no sling worn (group 2). Groups were created to differentiate which exposure was encountered first. Crossover testing was used, whereby each participant underwent gait and balance testing both with and without a sling; thus, each participant acted as an internal control. The order of testing—sling or no sling first—was randomly assigned for both groups using a computer-based random-number generator. Each participant then underwent gait and balance testing both without a sling and with a dominant upper extremity sling in the assigned order (eg, group 1—sling first, followed by without sling), thereby being included in both the control and the intervention groups. For each participant, the Edmonton Frail Scale (EFS) was administered before the evaluation of gait and balance. A single member of the study personnel conducted both the EFS and the Tinetti gait and balance scale throughout the entirety of testing of gait and balance. In addition, demographic information was collected, including age, sex, and hand dominance.

Evaluation of Frailty

Participants were assessed via the EFS, a validated assessment tool of frailty in the geriatric population.[17] This assessment poses a series of questions targeted to measure frailty as a product of cognitive impairment, balance and mobility, and function independence, among others. The scale is scored out of 17 points, with a higher score positively correlating with frailty. A score of 0 to 5 represents no frailty. As a final assessment after the EFS participants underwent the "Get Up and Go" test, a subset of the EFS, to measure balance and mobility.

Evaluation of Gait and Balance

Balance was assessed using the Tinetti gait and balance scale, a validated risk assessment tool widely used in the geriatric population to assess functional mobility.[18] Participants completed the Tinetti scale after undergoing the gait and balance assessment both with and without a sling on the dominant upper extremity. The Tinetti scale consists of three scores: gait score out of 12 points, balance scores out of 16 points, and total combined gait and balance score out of 28 points. Higher scores correlate with better balance, and scores higher than 24 indicate that the participant has a low fall risk. Participants with scores less than 19 are at high risk of falls.

Finally, participants completed a subjective outcome survey to quantify fear of falling, sling comfort, and perceived instability associated with sling use. Sling comfort was measured in two states (stationary and moving) on a scale from 0 (very comfortable) to 10 (unbearable). Perceived instability was measured on a scale from 0 (not anxious) to 10 (very anxious) regarding fear of falling while wearing the sling.

Statistical Analysis

All of the statistical tests were performed using SPSS Statistics version 27 (IBM SPSS Statistics, Armonk, NY). Differences in sex and age between both groups were assessed with a χ^2 test and a two-tailed *t* test, respectively. Descriptive statistics were used to analyze patient characteristics and outcomes of the EFS and the Tinetti gait and balance assessment. The Mann-Whitney *U* test assessed the differences in EFS scores between both tested groups because these populations were nonparametric in nature. The Wilcoxon signed rank test was used to assess differences in balance, gait, and combined scores of the Tinetti gait and balance assessment with an alpha level of 0.05 and a confidence interval of 95%.

Results

Demographics

After inclusion and exclusion criteria, 50 patients were included in the study, 23 (46%) men and 27 (54%) women with a mean age of 72.2 years (Table 1). Group 1 (no sling first) consisted of 10 men and 13 women with an average age of 72.0. Group 2 (sling first) consisted of 13 men and 14 women with an average age of 72.3. There was no statistically significant difference in sex ($P = 0.741$) or age ($P = 0.422$) between the two groups. The majority of patients (86%) did not report preexisting walking or balance difficulties, and 78% of patients reported no falls in the 12 months before consent (Table 1).

EFS

No difference existed in mean EFS scores between groups 1 and 2 (sling first = 1.59, no sling first = 1.52; Table 1). The average score was less than 5 in both groups, classifying the participants as not frail.

Table 1. Baseline characteristics and EFS

Characteristic	Total (N = 50)	No sling 1st (n = 23)	Sling 1st (n = 27)
Sex: male, female	23, 27	10, 13	13, 14
Age, mean (SD), y	72.2	72.0 (4.82)	72.3 (5.62)
Range, y	65–84	65–83	65–84
Fall in previous 12 mo (%)	11 (22)	2 (9)	9 (33)
Difficulty with walking and balance (%)	7 (14)	2 (9)	5 (19)
Sought medical attention due to fall (%)	16 (32)	5 (22)	11 (41)
Regularly worry about falling (%)	17 (34)	7 (30)	10 (37)
EFS mean score[a] (SD)	—	1.52 (1.62)	1.59 (1.56)
EFS range[a]	—	0–6	0–5

EFS, Edmonton Frail Scale; SD, standard deviation.
[a]*Scoring: 0–5, not frail; 6–7, vulnerable; 8–9, mild frailty; 10–11, moderate frailty; 12–17, severe frailty.*

Tinetti Gait and Balance

For no-sling immobilization, balance and gait score medians were 16.00 and 12.00, respectively (Fig. 1). For sling immobilization, balance and gait score medians were 15.00 and 11.50, respectively (Fig. 2). Balance and gait scores were significantly greater when patients were not wearing a shoulder sling, with a P value of 0.006 and 0.011, respectively (Table 2). The overall combined gait and balance score median values for no-sling immobilization and sling immobilization were 27.00 and 26.00, respectively ($P = 0.001$) (Fig. 3). The median combined scores for both groups were 24 or higher, which indicates a low risk of falls in our patient population that was selected with a strict inclusion and exclusion criteria.

Sling Fall Questionnaire

Table 3 presents the results of three questions regarding sling comfort and anxiety about falling after completion of gait and balance testing. Patients reported an average score of less than 1 regarding sling comfortability while stationary and while moving, indicating that the sling was very comfortable (Table 3). Regarding anxiety about falling while wearing the sling, patients reported an average score of 0.16, indicating little to no anxiety.

Discussion

This study demonstrates that patients wearing a sling experience statistically significant gait and balance compromise. In current practice, shoulder sling immobilization is common in shoulder care and during the early postoperative period to permit facilitate comfort and healing.[2,3] Slings, however, often are cumbersome and can affect patient function, especially in older adults, and can pose significant limitations to postoperative activity, lasting for several weeks.[19]

Using the Tinetti gait and balance assessment, we were able to demonstrate significantly worse balance ($P = 0.006$), gait ($P = 0.011$), and combined scores ($P = 0.001$) in patients wearing a sling. Because all of our study patients had a similar baseline fall risk, this analysis supported our hypothesis that sling use negatively affects balance and stability and may place the geriatric population at a heightened risk of falls. It should be noted that although this study found that participants with shoulder immobilization had statistically significant worse balance and gait, the

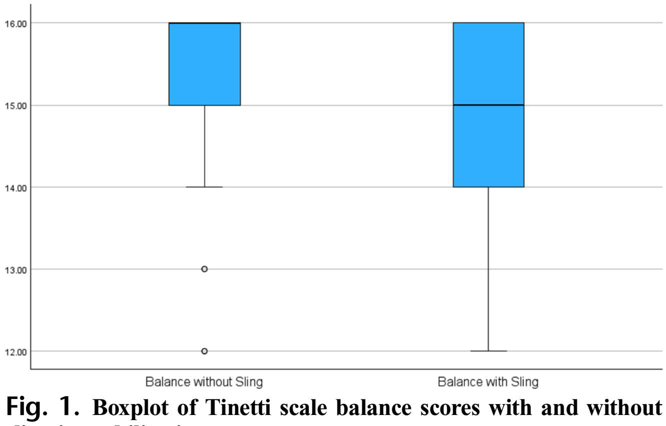

Fig. 1. **Boxplot of Tinetti scale balance scores with and without sling immobilization.**

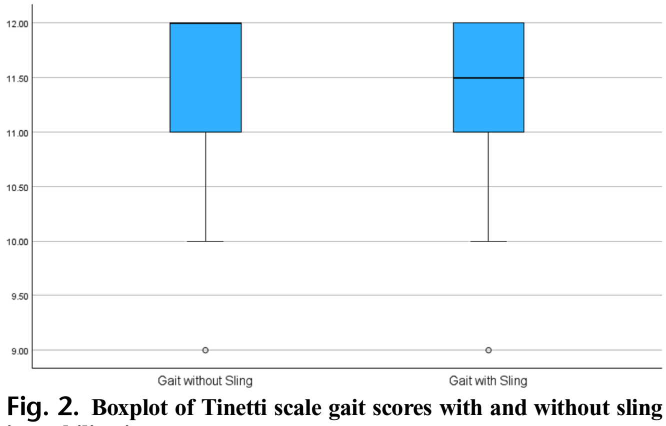

Fig. 2. **Boxplot of Tinetti scale gait scores with and without sling immobilization.**

Table 2. Tinetti assessment of balance and gait

Outcome	No immobilization	Immobilization	*P*
Median balance score (IQR)[a]	16.00 (1.00)	15.00 (2.00)	0.006
Median gait score (IQR)[b]	12.00 (1.00)	11.50 (1.00)	0.011
Median combined score (IQR)[c]	27.00 (2.00)	26.00 (2.00)	0.001

IQR, interquartile range.
[a]*Out of 16 points*
[b] *Out of 12 points*
[c]*Out of 28 points: high risk ≤18; moderate risk 19–23; low risk ≥24.*

difference in balance, gait, and combined scores was small. It is unclear whether the statistically significant differences found in this study would translate to clinical significance. The participants in this study were not considered frail or to have a heightened risk of injury, however. As such, based on the statistically significant differences in balance and gait found in this study, it is reasonable to anticipate that sling use following shoulder surgery or fracture treatment combined with analgesic medications may have an even greater impact on those with higher preoperative EFS scores or those who experienced significant comorbidities that affect their balance and gait at baseline. Overall, these findings are consistent with the current literature regarding natural arm swing mechanics and their importance in the maintenance of balance and gait. SABs limit these stabilizing natural motions.[20,21] In concordance with our findings, clinicians should scrutinize SAB usage in geriatric patients and balance the need for comfort and tissue healing versus the risk of falls. This is particularly true of the older adult fracture population, which frequently has fractures as a result of low-energy falls. Further research is needed to better understand whether our findings extend to the use of basic slings and other abduction pillows, however.

Early motion rehabilitation has been gaining acceptance as a possible solution for postoperative care that is less functionally impairing than slings and SABs.[3,6,22] Although this movement is primarily concerned with the outcomes of tendon healing and recovery postoperatively, changes in these postoperative protocols do alter and potentially minimize the amount of time spent in slings and may help reduce impairment due to sling usage. When used appropriately, the initiation of early motion rehabilitation can provide reduced pain and stiffness and offer an earlier return to activities without potentially placing the same long-term burden on patients as the current SAB apparatuses.[1–3,6,8,22] Early motion rehabilitation is not without its risks, however, and some conflicting literature suggests that earlier motion may lead to greater rotator cuff retear rates following surgery, particularly in those with larger tears at presentation.[23] In addition, there are also concerns for incomplete tendon healing and long-term effects of early mobilization.[6,22,23] Appropriate patient selection and risk stratification by clinicians is important in weighing early motion rehabilitation versus sling immobilization. Shoulder immobilization may not be suited for all patient populations, but it certainly does have benefits for patients following rotator cuff repairs.

Although the physical therapy outcomes are well studied, the idea of sling versus no sling within these regimens remains an important issue. Many newer physical therapy protocols use SABs or slings for varying time frames in early motion rehabilitation protocols, but do not call for the extended use of SABs like traditional postoperative protocols. In one study, Tirefort et al focused on postoperative mobilization following rotator cuff repair in patients who received a prescription for postoperative sling use versus those who did not.[24] They found there was no difference in pain 10 days postoperatively. At 6 months, no difference was identified in tendon thickness, bursitis, echogenicity, or repair integrity.[24] More important, patients who were not immobilized with a sling reported higher Single Assessment Numeric Evaluation scores and lower Visual Analogue Scale pain scores at 6 months when compared with those with sling use.[24] Sling use prioritizes comfort and healing, whereas limiting sling use prioritizes joint motion and balance, and clinicians should tailor treatment in light of the condition of the shoulder and the patient.

This study is not without limitations. Our study population was placed in slings for short periods of time, and a full appreciation of their limitations was likely not ascertained. Our patients also were generally healthy and lacked the typical complications associated with mobility or balance that would be found in the

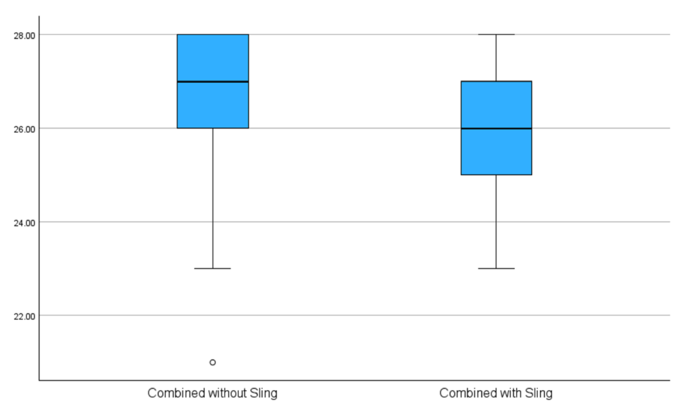

Fig. 3. **Boxplot of Tinetti scale combined gait and balance scores with and without sling immobilization.**

Table 3. Sling fall questionnaire

Outcome	Sling comfortability while stationary[a]	Sling comfortability while moving[a]	Anxious about falling while wearing sling[b]
Average (SD)	0.64 (1.27)	0.74 (1.38)	0.16 (0.51)
Range	0–6	0–6	0–2

SD, standard deviation.
[a]*Scale from 0 to 10: 0, very comfortable; 10, unbearable.*
[b]*Scale from 0 to 10: 0, not anxious; 10, very anxious.*

general geriatric population. This could have led to our lower EFS and higher Tinetti scores at baseline. In addition, because these were healthy patients, their ratings of comfort in their EFS testing likely would be different if measured postoperatively in patients who would have been wearing their slings for prolonged periods of time. Also, there are no published minimal clinically important differences for Tinetti and EFS that are relevant to this population. Due to this, we were able to show statistical differences between groups, but we cannot say whether this is a clinically significant outcome as a result of this study. The strict inclusion criteria set by the confines of this study allowed for a relatively small study population. In addition, this study focused on SABs, but it did not study canvas slings or other sling-like structures such as abduction pillows. Further research is warranted to see whether these findings are similar with other types of slings as well.

Conclusions

Sling immobilization of the shoulder is common in the older adult population, and the use of SABs negatively affects balance and gait, potentially increasing the risk of postoperative falls in an already at-risk population. Further research is needed to understand the clinical impact of the negative changes in balance and gait scoring noticed in this study.

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