The Effect of Arm Slings on Balance in Young Adults

Ben S. Rhee BA[1], Neel Vishwanath BS[1], Joseph Crozier BS[2], Loree K. Kalliainen MD MA FACS [2]

1. The Warren Alpert Medical School of Brown University, Providence, RI

2. Division of Plastic Surgery, The Warren Alpert Medical School of Brown University, Providence, RI

Introduction

An arm sling is commonly used to help heal a broken limb by limiting its movement. While its benefits have been clearly established, it also may have drawbacks that have not been fully studied yet.

There have been a scattering of studies that have shown how slings can affect balance in patients with hemiplegia or after suffering a stroke, but thus far, minimal research has looked into the role of arm slings in causing imbalance in individuals who wear the sling, especially young adults over the age of 18.

The purpose of this project is to add research literature to the relationship between arm slings and impaired balance, which can lead to further bodily harm. It also aims to question the common use of the arm sling when treating shoulder, elbow, and wrist injuries by demonstrating how the drawback of imbalance outweighs the benefit of the sling. This project is a clinical trial of healthy young adults over the age of 18 and has the following aims:

1. To assess how much more imbalance occurs in young adults with an arm sling vs. without.
2. To determine the characteristics of young adults who experience a greater degree of imbalance when wearing an arm sling.

We hypothesize that wearing a sling will impair overall stability in young adults over 18 compared to not wearing a sling.

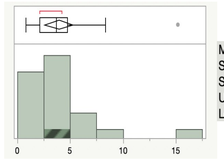
Methods

Recruited subjects balanced on a BioDex Balance System platform, one time with a sling and one time without. The order in which each subject balances with or without a sling was randomized, with half of the subjects wearing a sling first to balance and then without, and vice versa. To monitor subject safety during the trials, research coordinators were on either side of the balance board to prevent any falls off the platform.

Demographic information, including age, gender, ethnicity, race, height, and weight were recorded for each subject. Overall stability index, anterior/posterior stability index, medial/lateral stability index, and associated standard deviations were calculated and recorded for each trial that the subject balanced on the board, either with or without the sling.

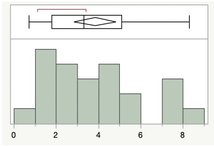
Results

Distributions



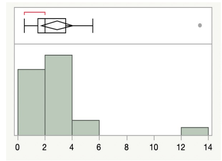
Mean	3.9130435
Std Dev	3.0959364
Std Err Mean	0.6455474
Upper 95% Mean	5.2518268
Lower 95% Mean	2.5742602

Overall Stability Index Scores (without sling)



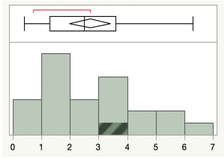
Mean	3.8347826
Std Dev	2.3105703
Std Err Mean	0.4817872
Upper 95% Mean	4.8339481
Lower 95% Mean	2.8356171

Overall Stability Index Scores (with sling)



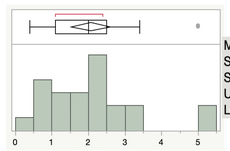
Mean	2.8826087
Std Dev	2.6634994
Std Err Mean	0.555378
Upper 95% Mean	4.0343922
Lower 95% Mean	1.7308252

Anterior/Posterior Stability Index Scores (without sling)



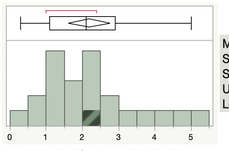
Mean	2.6956522
Std Dev	1.657621
Std Err Mean	0.3456379
Upper 95% Mean	3.4124613
Lower 95% Mean	1.9788431

Anterior/Posterior Stability Index Scores (with sling)



Mean	2.0608696
Std Dev	1.2576093
Std Err Mean	0.2622297
Upper 95% Mean	2.6047006
Lower 95% Mean	1.5170385

Medial/Lateral Stability Index Scores (without sling)



Mean	2.1826087
Std Dev	1.314483
Std Err Mean	0.2740887
Upper 95% Mean	2.7510338
Lower 95% Mean	1.6141836

Medial/Lateral Stability Index Scores (with sling)

Paired t-tests

Overall Stability Index Score

	Sling	*No Sling*
Mean	3.83478261	3.91304348
Variance	5.33873518	9.58482213
Observations	23	23
Pearson Correlation	0.58325627	
Hypothesized Mean Difference	0	
df	22	
t Stat	-0.1463278	
P(T<=t) one-tail	0.44249758	
t Critical one-tail	1.71714437	
P(T<=t) two-tail	0.88499515	
t Critical two-tail	2.07387307	

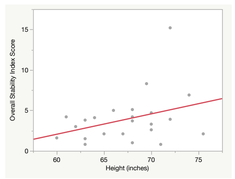
Anterior/Posterior Stability Index Score

	Sling	*No Sling*
Mean	2.69565217	2.8826087
Variance	2.74770751	7.09422925
Observations	23	23
Pearson Correlation	0.43784166	
Hypothesized Mean Difference	0	
df	22	
t Stat	-0.36678284	
P(T<=t) one-tail	0.3586426	
t Critical one-tail	1.71714437	
P(T<=t) two-tail	0.71728519	
t Critical two-tail	2.07387307	

Medial/Lateral Stability Index Score

	Sling	*No Sling*
Mean	2.182608696	2.06086957
Variance	1.727865613	1.58158103
Observations	23	23
Pearson Correlation	0.682031491	
Hypothesized Mean Difference	0	
df	22	
t Stat	0.568551226	
P(T<=t) one-tail	0.28770954	
t Critical one-tail	1.717144374	
P(T<=t) two-tail	0.57541908	
t Critical two-tail	2.073873068	

Regression Analysis



Overall Stability Index by Height (without sling)

Summary of Fit

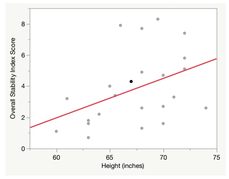
RSquare	0.117995
RSquare Adj	0.075995
Root Mean Square Error	2.975974
Mean of Response	3.913043
Observations (or Sum Wgts)	23

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	24.88120	24.8812	2.8094
Error	21	185.98489	8.8564	Prob > F
C. Total	22	210.86609		0.1085

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-13.0442	10.13594	-1.29	0.2121
Height (inches)	0.2516236	0.150122	1.68	0.1085



Overall Stability Index by Height (with sling)

Summary of Fit

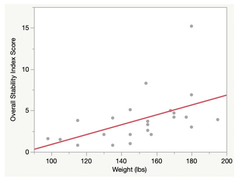
RSquare	0.176118
RSquare Adj	0.136885
Root Mean Square Error	2.146612
Mean of Response	3.834783
Observations (or Sum Wgts)	23

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	20.68539	20.6854	4.4891
Error	21	96.76979	4.6079	Prob > F
C. Total	22	117.45217		0.0462*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-13.22011	8.061969	-1.64	0.1159
Height (inches)	0.2530726	0.119445	2.12	0.0462*



Overall Stability Index by Weight (w/o sling)

Summary of Fit

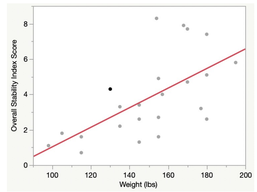
RSquare	0.249504
RSquare Adj	0.213766
Root Mean Square Error	2.745161
Mean of Response	3.913043
Observations (or Sum Wgts)	23

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	52.61199	52.6120	6.9815
Error	21	158.25410	7.5359	Prob > F
C. Total	22	210.86609		0.0152*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-5.062565	3.444841	-1.47	0.1565
Weight (lbs)	0.0599556	0.022555	2.64	0.0152*



Overall Stability Index by Weight (with sling)

Summary of Fit

RSquare	0.386854
RSquare Adj	0.357656
Root Mean Square Error	1.851837
Mean of Response	3.834783
Observations (or Sum Wgts)	23

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	45.43683	43.4368	13.2496
Error	21	72.01534	3.4293	Prob > F
C. Total	22	117.45217		0.0015*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-4.50636	2.323829	-1.94	0.0660
Weight (lbs)	0.0553829	0.015215	3.64	0.0015*

Takeaways/Conclusions

- There was no significant relationship between sling/no-sling usage and overall/anterior-posterior/medial-lateral stability index scores.
- Regression analysis revealed significant association between higher stability index and height/weight.
- No evidence was found to suggest that slings impact balance – however, higher weight and height may be associated with worse balance when wearing a sling.

Future Directions

- Recruit more subjects to obtain a larger sample size to draw from.
- Expand IRB permissions to include subjects with actual MSK injuries that require an upper extremity sling.

References

1. Lin L-C, Liao C-D, Wu C-W, Huang S-W, Hong J-P, Chen H-C. Effect of arm sling application on gait and balance in patients with post-stroke hemiplegia: a systematic review and meta-analysis. *Sci Rep*. 2021;11(1):11161. doi:10.1038/s41598-021-90602-y
2. Sohn MK, Jee SJ, Hwang P, Jeon Y, Lee H. The Effects of Shoulder Slings on Balance in Patients With Hemiplegic Stroke. *Ann Rehabil Med*. 2015;39(6):986. doi:10.5535/arm.2015.39.6.986
3. Acar M, Karatas GK. The effect of arm sling on balance in patients with hemiplegia. *Gait Posture*. 2010;32(4):641-644. doi:10.1016/j.gaitpost.2010.09.008
4. Lui DF, Memon A, Kwan S, Mullett H. Computerized dynamic posturography analysis of balance in individuals with a shoulder stabilization sling. *Eur J Trauma Emerg Surg*. 2013;39(6):635-639. doi:10.1007/s00068-013-0309-z

Acknowledgments

The authors would like to thank Joseph Crozier, BS and Loree K. Kalliainen, MD MA FACS for their continued support and guidance throughout the duration of this project. We would also like to thank the AMS Summer Assistantship Program for its generous funding and support of this project.