MUSCLE ACTIVATION AND HAND TRAVELING DISTANCE IS REDUCED WHEN USING AN INNOVATIVE ATTACHABLE RADIATION REDUCTION EXTENSION SUPPORT SHEATH

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INTRODUCTION

Interventional radiology procedures access patient vessels through what is known as a vascular sheath. Common sheath access problems cause difficulty inserting and manipulating tools through the sheath, which often requires awkward postures and movements by the interventional radiologist to successfully complete the procedure. Over time, as interventional radiologists perform many procedures, such non-optimal positions and movements can lead to ergonomic problems including back and neck pain. Therefore, it is important to minimize these occupational health hazards to preserve highly trained physicians and allow optimal completion of intervention procedures. A new attachable radiation reduction extension support sheath (ARRESS) was developed to address this problem. The purpose of this study was to quantitatively assess the effectiveness of the new sheath in improving the occupational environment (muscle activity) and procedure proficiency (movement distance) during interventional procedures. Muscle activity of the trunk and upper extremities and total movement distance were compared between procedures that used the standard sheath and the ARRESS sheath during antegrade common femoral artery access and intervention procedures.

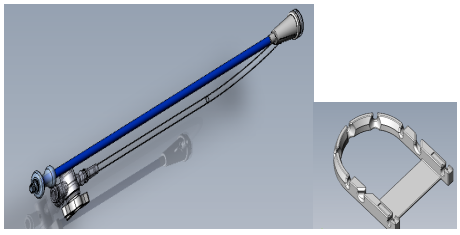

Figure 1. Attachable radiation reduction extension support sheath (ARRESS sheath)

METHODS

Seven physician operators performed the procedure on a swine model with critical limb ischemia. Bilateral anterograde common femoral artery access was obtained (with and without ARRESS; total of four procedures per physician) along with balloon angioplasty of the runoff vessel, followed by balloon angioplasty and stent deployment of the superficial femoral artery equivalent. The ARRESS extension sheath is designed so that a universal sheath attachment, combined with a bendable and malleable shaft, secures to a multi-positional adhesive securement clasp (figure 1); thus allowing physicians to adjust the sheath based on the access location. During the procedure muscle activity of the trunk and upper extremities were measured with electromyography (Trigno Wireless System, Delsys, Natick, MA, USA). Eight electromyographic sensors with accelerometers were attached bilaterally on abductor pollicis brevis, flexor carpi radialis, trapezius, and latissmus dorsi. Total muscle activity was calculated as the sum of the activity of the eight muscles. Generated muscle power was calculated as the total muscle activation divided by the max muscle activity. Mean muscle activity was calculated as the total muscle activation (% of max) divided by the procedure time. Both measures were calculated for each of the four procedures.

In addition, integrating acceleration data from sensors placed on the hand provided hand traveling distance. Each surgeon started the procedure in the same location. Total hand traveling distance has been widely used to determine the proficiency of surgical skill. In the current study, total hand traveling distance was calculated as the sum of the two hands' traveling distances in each procedure. Bilateral procedures were averaged, leaving two conditions (ARRESS and standard sheath). Paired t-tests were used on each dependent variables to

investigate the effect of ARRESS in comparison to standard sheath and $\alpha = 0.05$.

RESULTS

Using the ARRESS reduced the mean muscle activity ($p < 0.001$) and mean generated muscle power ($p < 0.001$) significantly in comparison with using the standard sheath (Table 1). Less muscle activity equates with higher proficiency and less potential fatigue or pain in the performing physician. In addition, hand traveling distance was significantly reduced ($p < 0.001$) while using ARRESS sheath compared with using the standard sheath (Figure 2). Less traveling distance infers higher proficiency; as unnecessary movements would increase the traveling distance.

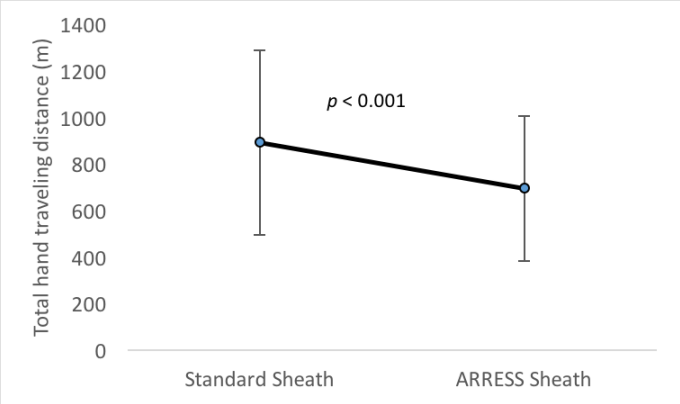

Figure 2. The total hand traveling distance (Standard vs ARRESS Sheath)

CONCLUSIONS

Despite the increasing popularity of endovascular surgeries, many interventional procedures are routinely hampered by ergonomic limitations and occupational health hazards for interventional radiologists. This study tested whether a newly designed access sheath, the ARRESS, was able to decrease the fatigue and increase surgical proficiency by examining muscle activity and power and hand traveling distance. Our results support that the ARRESS sheath has potential occupational health benefits for the highly trained physicians and it promotes optimal completion of each procedure.

Differences in muscle activity and generated power and traveling distance may not be noticed by physicians over the course of one procedure. However, these physicians typically perform many procedures like this each day for years. Over time, these reductions in muscle activity, power, and hand traveling distance may decrease the risks of chronic musculoskeletal injuries that are becoming increasing common in intervening physicians. The ARRESS device should be tested further to establish potential benefits for ergonomic health and operating efficiency.

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Table 1: Generated muscle power and mean muscle activation

	Standard Sheath	ARRESS Sheath	
Mean muscle activation (% of Max-time)	0.25±0.08	0.21±0.07	$p < 0.001$
Generated muscle power (% of Max)	4.47±2.98	3.48±2.31	$p < 0.001$