

Evaluation Of Needle Length And Injection Site To Maximize Successful Intramuscular Inoculations And Minimize Overpenetration During Intramuscular Deltoid Vaccinations

Kevin A Hao, Markos Mardourian, Jonathan O Wright¹, Jonathan Arias, Whitman Bertram Wiggins, Joseph John King², Aimee Struk¹, Thomas W Wright³

¹University of Florida, ²UF Orthopaedics & Sports Medicine Institute, ³UF Orthopaedics

INTRODUCTION:

Shoulder injury related to vaccine administration (SIRVA) has recently received increased attention in the literature due to COVID vaccinations. Current recommendations for needle length and vaccination site for intramuscular deltoid vaccinations are varied, and there are relatively few studies to support these recommendations. This study reviewed shoulder anatomy from imaging on a cohort of patients to determine the most appropriate needle length and site for intramuscular deltoid vaccine administration.

METHODS:

120 shoulder computed tomography scans were evaluated and divided into four groups by patient weight and sex as recommended by the United States Center for Disease Control (CDC) for adult intramuscular vaccination: Group 1, < 60 kg (n=23), Group 2, 60 – 70 kg (n=17), Group 3, females 70 – 90 kg and males 70 – 118 kg (n=55), and Group 4, females > 90 kg and males > 118 kg (n=25). For each, distance from skin to deltoid fascia and deltoid muscle width were measured at 2, 4, and 6 cm distal to the posterolateral corner of the acromion for 3 vectors orthogonal to the sagittal plane and in line with either the anterolateral corner of the acromion (AL), the mid-point of the acromion (ML), or the posterolateral corner of the acromion (PL). Needle lengths of 0.625", 1.0", and 1.5" as recommended by the CDC were evaluated at each site to determine if the tip of the needle would be superficial to, inside, or deep to the deltoid muscle.

RESULTS:

For Group 1, a 0.625" needle in the PL vector 2 cm distal to the posterolateral corner provided the highest rate of successful inoculations (96%) and low rate of overpenetration (0%). Use of a 1" needle in the PL vector 4 cm distal to the posterolateral corner provided an identical rate of successful inoculations (96%), but had a slightly higher rate of overpenetration (5%). For Groups 2-3, a 1" needle at the site 6 cm distal in the PL vector provided the highest rates (>90%) of successful intramuscular inoculations with the lowest rates of overpenetration (0% in both groups). For Group 4, a 1.5" needle in the PL vector provided the highest rate of successful inoculations (96%) and low rate of overpenetration (4%), but at a distance 4 cm distal. A significant trend of overpenetration of the deltoid was associated with more anterior and superior injection sites ($P < 0.001$ for both) for all needle lengths.

DISCUSSION AND CONCLUSION:

The best injection site overall to maximize successful intramuscular vaccine administration and minimize overpenetration in most shoulders is 6 cm distal to and in line with the posterolateral corner of the acromion, in contrast to typical recommendations suggesting a more anterolateral or midlateral injection site. Indeed, more anterior and superior injection sites have significantly higher rates of overpenetration. For the majority of patients, a 1" needle is appropriate, although in women > 90 kg or men > 118 kg, a 1.5" needle is best.

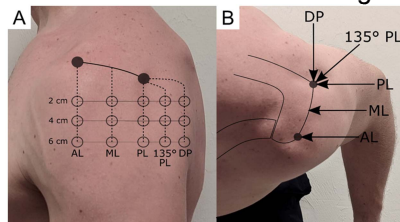


Figure 1. Needle entry paths assessed anterolateral (AL), midlateral (ML), posterolateral (PL), posterolateral at a 135° angle (135° PL), and direct posterior (PL) at 2, 4, and 6 centimeters (cm) below the acromion inferiorly as shown on lateral (A) and superior (B) views.

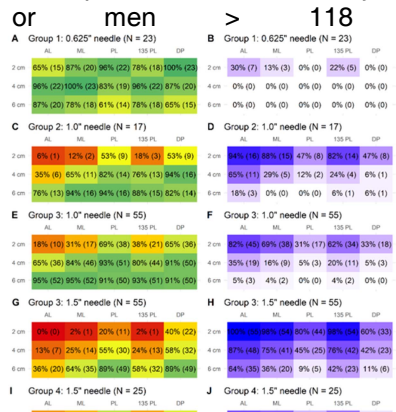


Figure 2. Heatmaps portraying the proportion of simulated needles that would penetrate within and over penetrate the deltoid muscle (respectively) using a 0.625" needle for group 1 (A and B), a 1.0" needle for group 2 (C and D), a 1.0" needle for group 3 (E and F), a 1.5" needle for group 3 (G and H), and a 1.5" needle for group 4 (I and J).

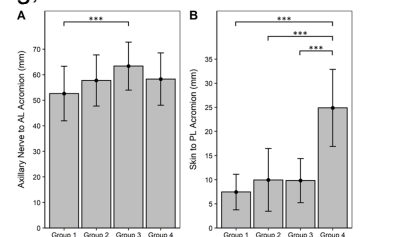


Figure 3. Comparison of the distance from the axillary nerve (A) to the anterolateral (AL) acromion (A) and from the skin to the posterolateral (PL) acromion between CDC vaccine recommendation groups. Statistical comparisons were made with analysis of variance. Post-hoc pairwise comparisons were performed with Tukey correction. *, $P < .05$; **, $P < .01$; ***, $P < .001$.