

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/mjafi

Original Article

Influence of skin-to-muscle and muscle-to-bone thickness on depth of needle penetration in adults at the deltoid intramuscular injection site



Nachiket Shankar ^{a,*}, Deepali Saxena ^b, Pooja P. Lokkur ^c,
Nikhil M. Kumar ^c, Neena Chris William ^c, Nirupama Vijaykumar ^c

^a Associate Professor, Department of Anatomy, St. John's Medical College, Bangalore 560034, Karnataka, India

^b Assistant Professor, Department of Radiology, St. John's Medical College Hospital, Bangalore, Karnataka, India

^c Intern, St. John's Medical College Hospital, Bangalore, Karnataka, India

ARTICLE INFO

Article history:

Received 24 April 2014

Accepted 5 August 2014

Available online 16 October 2014

Keywords:

Deltoid muscle

Injections

Intramuscular

Needles

Subcutaneous fat

ABSTRACT

Background: The objectives of the study were to estimate the following in adults of Indian origin: a) Gender and side differences in the skin-to-muscle (SM) and muscle-to-bone thickness (MB) at the deltoid intramuscular injection site; b) Correlation of SM thickness with the BMI, age and gender; c) The prevalence of under and over-penetration assuming a standard needle length of 25 mm and following prescribed guidelines for IM injection.

Methods: The SM, MB and skin-to-bone (SB) thicknesses were bilaterally estimated in two hundred adult Indian subjects (100 male and 100 female) using an ultrasound probe at a pre-determined point on the upper arms of the subjects. The BMI of each subject was calculated. The unpaired sample 't' test and paired 't' test were used to analyse differences between groups. Pearson's correlation coefficient was used in correlation analysis and suitable linear regression equations were generated.

Results: Females had a significantly higher SM thickness and lower MB thickness. The SM thickness was significantly greater on the left side, while the SB and MB thickness were significantly greater on the right. Multiple linear regression equations for both the dominant and non-dominant arms had good model fit properties. Under-penetration would have occurred in 2 (1%) subjects while over-penetration would have occurred in 50% of the subjects.

Conclusion: Over-penetration of deltoid IM injections is likely to be more prevalent as compared to under-penetration. Therefore, the technique of IM injection needs to be modified based on the body type of the individual patient.

© 2014, Armed Forces Medical Services (AFMS). All rights reserved.

* Corresponding author. Tel.: +91 80 22065061/62.

E-mail address: nachiket76@gmail.com (N. Shankar).

<http://dx.doi.org/10.1016/j.mjafi.2014.08.005>

0377-1237/© 2014, Armed Forces Medical Services (AFMS). All rights reserved.

Introduction

Intramuscular (IM) injections are commonly used to deliver vaccines and drugs in all age groups. The common sites of IM injections are the deltoid, vastus lateralis, ventro-gluteal and dorso-gluteal muscles. Most vaccines should be given via the IM route into the deltoid or vastus lateralis as this optimizes the immunogenicity of the vaccine and minimizes adverse reactions at the injection site.¹

Adequate penetration of the muscle for IM injections is defined as penetration of 5 mm or more into the muscle.² Under-penetration will lead to subcutaneous injection. Injecting a vaccine into the layer of subcutaneous fat will result in slow mobilization and processing of the antigen, causing vaccine failure due to poor vascularity.¹ Local reactions and complications such as irritation, inflammation, granuloma formation and necrosis are also more common with subcutaneous than IM injections.^{1–4} However, patients who are emaciated require shorter needles for IM injection. Potential risk of over-penetration include pain and damage to the bone or periosteum and detachment of the needle from the syringe.^{5,6}

A study conducted in the USA used ultrasound to determine the deltoid fat pad thickness in adult males and females.² It was found that women had a significantly thicker deltoid fat pad than men. A standard 16 mm needle would not have reached 5 mm into the muscle in 17% of the men and 48.4% of the women.² Similar studies have shown that problems with under-penetration are even more pronounced at the gluteal IM injection sites.^{7,8} In a study done in South Korea it was found that boys over 14 years of age had statistically significantly thinner subcutaneous tissue at all injection sites than that of age matched girls. It was also found that body mass index (BMI) was statistically significantly correlated with subcutaneous tissue thickness at all sites.⁹ An ultrasound study in elderly patients in Australia showed that BMI was strongly correlated with deltoid subcutaneous layer thickness in males ($r = 0.69$ dominant arm, 0.71 non-dominant arm) and females ($r = 0.79$ both arms). Females with the same BMI as males had significantly thicker subcutaneous layers ($p = 0.0001$) and thinner muscle layers ($p = 0.0003$).¹⁰

It thus follows that a standard size of needle will not guarantee successful IM injections in all people. When IM injections are to be administered, a selection of non-fixed needles should be available to allow healthcare professionals to select a length and gauge of needle appropriate to each patient.¹ Studies on the deltoid fat pad thickness have been conducted in Caucasian and South-East Asian populations. As there are likely to be significant racial differences, it was felt that it would be worthy of study in Indian populations as well.

The objectives of the study were to estimate the following in adults of Indian origin: a) Skin-to-muscle (SM) and underlying muscle-to-bone thickness (MB) at the deltoid intramuscular injection site; b) Differences of the above measurements between the right and left upper limbs; c) Gender differences in the above measurements; d) Correlation of the SM thickness and the BMI, age and gender; e) The prevalence of under-penetration and over-penetration assuming a standard needle

length of 25 mm and according to prescribed guidelines for IM injections.

Material and methods

Ethical clearance for the study was obtained from the Institutional Ethical Review Board. Written informed consent from all subjects participating in the study was taken. The study was a cross sectional, analytical study conducted at a tertiary medical college hospital in Bangalore. The data was collected between June and November, 2011. The subjects for the study were attendants of patients who came to the radiology department for investigation and who were over the age of 18 years. Those subjects who had any scarring of the upper arm region due to previous injuries or surgeries, pregnant women and subjects suffering from any chronic illnesses such as tuberculosis, chronic renal failure, chronic liver disease, and malignancies were excluded from the study. The subjects were selected at the convenience of the investigators usually between 12:30 pm and 1:30 pm or between 4:30 pm and 5:30 pm.

The sampling was purposeful to try and include subjects of varying BMIs and age groups. The dependent variable that was considered was the SM thickness, while the independent variables were the gender, BMI, arm dominance and age of the subject. The other variable that was considered was the MB thickness to assess the probability of over-penetration. The sample size was calculated for hypothesis testing to estimate the difference in means between two groups for a quantitative parameter using a sample size calculator called nMaster. A sample size of 200 for each side (right and left) was required to ensure a power of 80% and an alpha error of 5% assuming a standard deviation (SD) of 2.5 millimeters (mm) for both groups and a difference in means of 0.7 mm in the SM thickness. Therefore a total of 200 individuals, which included 100 males and 100 females were included in the study.

The dominant arm and gender of the subject were noted. The weight of the subject was recorded in kilograms in the radiology department using a single standard digital weighing machine. The height was recorded in centimeters using a wall mounted stadiometer, after which the BMI was calculated. The site for the deltoid IM injection was marked bilaterally with a skin marking pen using the method mentioned below. The tip of the acromion and lateral epicondyle of the humerus were palpated and marked with a skin marking pen. The mid-point between the above mentioned bony landmarks was marked and a vertical line was drawn between this point and the tip of the acromion. The junction of the upper one third and lower two third of this line was taken as the site for deltoid intramuscular injection (Fig. 1a).

Ultrasound measurements using a GE LOGIQ P6, 10 MHz linear probe were then made by a single co-investigator and interpreted by the same person. The arm of the subject was held in a relaxed position against the lateral thoracic wall. The ultrasound probe was held at 90° angle to the plane of the injection site, avoiding compression by the ultrasound probe (Fig. 1b). The ultrasound images were taken in the transverse plane. The SM thickness (yielding deltoid fat pad thickness) and MB thickness (yielding muscle thickness) measurements

Download English Version:

<https://daneshyari.com/en/article/3161245>

Download Persian Version:

<https://daneshyari.com/article/3161245>

[Daneshyari.com](https://daneshyari.com)