**Original Article**

# Comparison of Four Dorsogluteal and Ventrogluteal Sites for Safe Intramuscular Injection: A Cross-Sectional Study

**Nurcan Caliskan, PhD, RN**
**Professor, Gazi University Faculty of Health Sciences, Nursing Department, Ankara, Turkey**

**Emel Gulnar, PhD, RN**
**Assistant Professor, Kirikkale University, Faculty of Health Sciences, Nursing Department, Kirikkale, Turkey**

**Mikail Inal, PhD, MD**
**Associate Professor, Department of Radiology, School of Medicine, Kırıkkale University, Kirikkale, Turkey**

**Selmin Perihan Komurcu Erkmen, MD**
**Department of Radiology, School of Medicine, Kirikkale University, Kirikkale, Turkey**

**Sule Biyik Bayram, PhD, RN**
**Assistant Professor, Karadeniz Technical University, Faculty of Health Sciences, Department of Nursing, Trabzon, Turkey**

**Husna Ozveren, PhD, RN**
**Associate Professor, Kirikkale University, Faculty of Health Sciences, Nursing Department, Kirikkale, Turkey**

**Correspondence:** Emel Gulnar, PhD, RN, Assistant Professor, Kirikkale University, Faculty of Health Sciences, Nursing Department, Kirikkale, Turkey. Email: imel84@hotmail.com

**Abstract**

**Background:** There are debates concerning the use of dorsogluteal and ventrogluteal sites for safe intramuscular injection. The ventrogluteal site is the first choice, but sometimes health professionals prefer the dorsogluteal site for intramuscular injection due to such factors as subcutaneous, muscle, and tissue thicknesses, and needle size, which should, therefore, be determined for safe intramuscular injection.

**Aim:** The aim of this study was to compare the subcutaneous, muscle, and total tissue thicknesses of the dorsogluteal (posterior superior iliac spine and the greater trochanter of the femur and anterior superior iliac spine and coccyx) and ventrogluteal (V and G) sites for safe intramuscular injection.

**Methods:** This was a cross-sectional study. The sample consisted of 91 voluntary participating nurses. Intramuscular injection sites (dorsogluteal and ventrogluteal) were determined using anthropometric characteristics and four methods. Muscle, subcutaneous, and total tissue thicknesses were measured using ultrasonography.

**Results:** There was a significant difference in muscle, subcutaneous, and total tissue thicknesses between the dorsogluteal (posterior superior iliac spine and the greater trochanter of the femur and anterior superior iliac spine and coccyx) and ventrogluteal (V and G) ($p < .05$). Female participants had greater subcutaneous tissue thickness than males.

**Conclusions:** The results show that the ventrogluteal G site is the safest site for injection. If the ventrogluteal site is unsuitable, the dorsogluteal (anterior superior iliac spine and coccyx) site is a safe site for injection in terms of subcutaneous tissue thickness, presence of vessels, and distance to the nerve.

**Keywords:** intramuscular injection, dorsogluteal, ventrogluteal, ultrasound, subcutaneous tissue

## Introduction

Clinical nurses often administer intramuscular (IM) injections. Nurses are responsible for preparing and administering IM injections safely (Official Gazette, 2011; Greenway, 2014). Choosing the wrong IM injection site may result in nerve, vascular, and bone injury. The wrong needle size may cause the medication to be delivered to the subcutaneous (SC) tissue instead of the muscle. Therefore, choosing the right IM injection site and needle size can help prevent complications (Berman et al., 2016; Cocoman & Murray, 2010; Hopkins & Arias, 2013; Nicoll & Hesby, 2002; Potter et al., 2017).

A site for a safe IM injection can be identified using different methods, which have their own advantages and disadvantages (Potter et al., 2017; Larkin et al., 2017). Containing the gluteus medius muscle, the ventrogluteal (VG) site is located on the superior lateral and identified in the supine, lateral, and prone positions (Cocoman & Murray, 2010; Larkin et al., 2017). The dorsogluteal (DG) site contains the gluteus maximus muscle and used for repetitive and large volume injections (Larkin et al., 2017). The VG site is generally the first choice for IM injections because the DG site is in close proximity to the sciatic nerve and rich in blood vessels, and has thick subcutaneous tissue (Potter et al., 2017; Berman et al., 2016; Dinc, 2014). However, nurses use the DG site more often than the VG site (Gulnar & Caliskan, 2014; Šakić et al., 2012; Wynaden et al., 2015; Turan et al., 2019; Legrand et al., 2019) because they find the latter unreliable (due to its small anatomical structure), feel unconfident about using it because they have a hard time identifying it, think that hand length may prevent them from identifying it, lack enough knowledge and skills, fear harming patients, and difficulty in breaking old habits (Cocoman & Murray, 2010; Wynaden et al. 2015; Greenway, 2014; Nicoll & Hesby 2002; Greenway, 2004; Floyd & Meyer, 2007; Larkin et al., 2018a).

Two methods, namely V and G (geometric), are used to identify the VG site. However, there is an ongoing debate on which one is the safe method for identifying a DG or VG site for an IM injection (Brown et al., 2015; Cocoman & Murray, 2008; Wynaden et al., 2015; Larkin et al. 2017). Walsh and Brophy (2011) found that most nurses (71%) used the DG site whereas very few (14%) used the VG site for IM injections. They therefore concluded that the gluteal region should be mapped in a more reliable manner. Boyd et al. (2013) examined the tomography scans of IM injection patients and suggested that the VG site be used for IM injections only in underweight individuals. According to Larkin et al. (2017), the VG site should be the site of choice for IM injections, however, the DG site can also be used for IM injections in some cases. Hopkins and Arias (2013) assume that the top and outer quadrant of the DG site is in close proximity to the VG region, however, they do not specify what method to use to detect that region.

There are some studies investigating which of the V and G methods is more reliable to identify a VG site for safe IM injection (Kaya et al., 2015; Larkin et al., 2018b; Elgellaie et al., 2018). A safe DG site for IM injection can be identified using three methods, which are the quadrant method (Larkin et al., 2018a; Larkin et al., 2017), posterior superior iliac spine and the greater trochanter of the femur (PSIS-T), and anterior superior iliac spine and coccyx (ASIS-C) (Nicoll & Hesby, 2002; Karabacak, 2010; Sabuncu, 2008). The PSIS-T (Gunes et al., 2008; Zaybak et al., 2007). However, Small (2004) argues that the quadrant method is considered to be unsuitable for identifying DG sites for IM injections. Some Turkish textbooks address the ASIS-C method site (Karabacak, 2010; Sabuncu, 2008). Some studies have employed the V, G, and PSIS-T methods (Kaya et al., 2015; Larkin et al., 2018b; Gunes et al., 2008; Zaybak et al., 2007; Elgellaie et al., 2018). However, to our knowledge, no research has been conducted on the ASIS-C method. Therefore, this is the first study to assess the tissue thickness of an ASIS-C site for IM injection. The ASIS-C site can be used for IM injection in cases where the VG site is hard to identify because the former is in close proximity to the latter and away from nerves and blood vessels and has appropriate subcutaneous tissue thickness.

Choosing the right needle size is another important criterion for safe IM injection. For all IM injections, the needle should be long

enough to pass through the subcutaneous tissue and reach the muscle mass (Cocoman & Murray, 2008; Malkin, 2008). Cocoman and Murray (2008) state that longer needles should be used for IM injections to the DG site because it has thicker subcutaneous tissue than the VG site. Some studies recommend the use of needles 13 to 32 mm in length for IM injections to the VG site because it has a subcutaneous tissue thickness of 12.9 to 31.65 mm (Kaya et al 2015; Larkin et al 2018b). There is, however, no research on the subcutaneous tissue thickness of PSIS-T and ASIS-C sites for safe IM injection. We believe that subcutaneous tissue thickness is an important criterion for determining the safety of ASIS-C sites for IM injections. Therefore, the aim of this study was to compare the muscle, subcutaneous tissue, and total tissue thicknesses of PSIS-T and ASIS-C (dorsogluteal) and V and G (ventrogluteal) sites and determine the sizes of needles needed for safe IM injections to those sites.

## Method

**Aim and design:** The aim of this cross-sectional study was to compare the muscle, subcutaneous tissue, and total tissue thicknesses of PSIS-T and ASIS-C (dorsogluteal) and V and G (ventrogluteal) sites. Data were collected between May 2019 and February 2020.

**Participants:** The sample consisted of 91 voluntary participating nurses . The inclusion criteria were as follows:

- At least 18 years of age
- No restrictions on mobility
- Voluntary

Power Analysis performed using G*Power 3.1.9.2. Type of power analysis is post-hoc test. The result showed that the sample size of 91 would be sufficient to detect significant differences (power of 99%, $p < 0.05$, the effect size = 0.69, df: 90). Participation was voluntary. Nurses were informed about the study prior to participation. Written and verbal consent was obtained from those who agreed to participate.

**Data collection:** Data were collected using an anthropometric characteristics questionnaire and an ultrasound record form developed by the researchers based on literature review (Gunes et al., 2008; Larkin et al., 2017; Larkin et al., 2018a; Zaybak et al., 2015). The anthropometric characteristics questionnaire consisted of items on age, gender, body length, body weight, Body Mass Index (BMI), and waist, hip, mid-thigh, and upper thigh circumference, and the distance between the greater trochanter and the anterior superior iliac spine (GTASIS), between the greater trochanter and the iliac tubercle (GTIT), and between the iliac tubercle and anterior superior iliac spine (ITASIS) on both sides.

The ultrasound record form consisted of the records of the muscle, subcutaneous, and total tissue thicknesses and the presence/absence of arteries or nerves on the V, G, PSIS-T, and ASIS-C sites on the right and left gluteal regions.

**Procedure:** Body weight and length and socio demographic characteristics were determined. Afterwards, V, G, PSIS-T, and ASIS-C sites were determined by the same researcher to avoid interpersonal differences in terms of hand structure.

The V- and G-method sites were determined on the VG site. For V-method site identification, the participant was placed in the right or left lateral position. The researcher placed her left hand (for the right hip) or right hand (for the left hip) on the greater trochanter of the femur. She moved her thumb toward the groin and moved her index finger toward the anterior superior iliac spine and extended her middle finger as far back as possible. The index finger and middle finger form a V shape, the middle of which would be the V injection site (Potter et al., 2017; Berman et al., 2016; Dinc, 2014). This method was referred to as “V-method” in this study.

For G-method site identification, the participant was placed in the right or left lateral position. The researcher marked the greater trochanter, anterior superior iliac spine, and iliac tubercle and drew a triangle by connecting adjacent marked landmarks, and then, found the centroid of the triangle by drawing a line from the mid-point of each side of the triangle to the opposite vertex (Kaya et al., 2015; Meneses, 2007). This method was referred to as “G-method” in this study.

The ASIS-C- and PSIS-T- method sites were determined on the DG site. The first method named in this study was “PSIS-T”, and the second one was “ASIS-C” (Hunter, 2008; Sabuncu, 2008, Karabacak, 2010). The PSIS-T site is the region above the line connecting

the posterior superior iliac spine and the greater trochanter of the femur. For ASIS-C DG injection site identification, a straight line is drawn between the anterior superior iliac spine and the coccyx, and then, that line is divided into three equal parts. The ASIS-C site is the midpoint of the one-third of the outer part (Karabacak, 2010; Sabuncu, 2008). The researchers marked the V, G, PSIS-T, and ASIS-C sites as 1, 2, 3, and 4, respectively. The researcher performing the ultrasound was blinded to the assignment of the type of method. Another researcher placed the probe of the ultrasound (linear probe, 13~5Mhz, FOV width 50 mm, HITACHI Preirus Ultrasound Scanner, Tokyo-Japan) at a 90-degree angle perpendicular to the skin surface and recorded (on the ultrasound record form) the subcutaneous tissue and gluteus maximus, medius and minimus thicknesses, and the presence/absence of vessels and nerves on the landmarks. The researcher was blinded to the methods that had been used to locate the injection sites.

**Statistical analysis:** Data were analyzed using the Statistical Package for Social Sciences (SPSS, v. 21, IBM Inc., Chicago, IL, USA) at a significance level of 0.05. Median, minimum, and maximum and arithmetic mean (standard deviation [SD]) were used for ordinal data evaluation. The Kolmogorov–Smirnov test was used for normality testing. The data were normally distributed, and therefore, student's t-test, paired sample t-test, analysis of variance (ANOVA), one-way ANOVA, and Pearson's correlation coefficient were used for analysis.

**Ethical considerations:** The study was conducted according to the ethical principles outlined by the World Medical Association's Declaration of Helsinki. The study was approved by the Clinical Research Ethics Committee (Decision No: 15/08, Decision Date: 01.10.2018). Nurses were informed about the purpose, procedure, and confidentiality of the study prior to participation. Written and verbal consent was obtained from those who agreed to participate.

## Results

Seventy-four participants (81.3%) were female. Table 1 shows the physical characteristics of the participants. There was a significant difference in muscle, subcutaneous, and total tissue thicknesses between the injection sites ($p<0.05$). The muscle, subcutaneous, and total tissue thicknesses from highest to lowest was DG>ASIS-C>V>G, PSIS-T>V>ASIS-C>G, and ASIS-C>PSIS-T>V>G, respectively (Table 2).

There was a significant difference in muscle, subcutaneous, and total tissue thicknesses of the V, ASIS-C, and PSIS-T injection sites between male and female participants ($p<0.05$). Female participants had lower muscle tissue thickness but greater subcutaneous tissue and total tissue thicknesses than males ($p<0.05$) (Table 3).

Body Mass Index had a significant effect on the muscle, subcutaneous, and total tissue thicknesses of the V, ASIS-C, and PSIS-T injection sites ($p<0.05$). Obese participants had the highest muscle, subcutaneous, and total tissue thicknesses, while underweight participants had the lowest ($p<0.05$) (Table 4).

There was a significant difference in muscle thicknesses between the right and left gluteal regions in the G and PSIS-T injection sites ($p<0.05$). There was a significant difference in subcutaneous and total tissue thicknesses between the right and left gluteal regions in the V and G injection sites ($p<0.05$) (Table 5).

Veins were observed in seven participants; one in the V site; two between the G and ASIS-C sites; one between the PSIS-T and ASIS-C sites; one in the PSIS-T site; and two in the ASIS-C site.

**Table 1. Physical Characteristics and Injection Site Measurements**

| Variable | Mean±SD | Median | Min.-Max. |
|---|---|---|---|
| **Age (years)** | 20.36±1,50 | 20.00 | 18.00-27.00 |
| **Height (cm)** | 1.66±0.08 | 1.65 | 1.48-1.88 |
| **Weight (kg)** | 60.89±12.14 | 59.00 | 33.00-95.00 |
| **BMI (kg/m$^2$)** | 22.09±3.83 | 21.50 | 13.70-38.00 |
| **Waist circumference (cm)** | 76.27±9.53 | 75.00 | 59.00-108.00 |
| **Hip circumference (cm)** | 97.43±8.40 | 96.00 | 81.00-126.00 |
| **Mid-thigh circumference (cm)** | 48.36±5.74 | 49.00 | 38.00-69.00 |
| **Upper thigh circumference (cm)** | 56.72±5.82 | 57.00 | 43.00-74.00 |
| **R_GT-ASIS (cm)** | 16.68±2.73 | 17.00 | 5.00-28.00 |
| **R_GT-IT (cm)** | 21.25±2,61 | 22.00 | 14.00-27.00 |
| **R_IT-ASIS (cm)** | 18.75±2.52 | 19.00 | 12.00-26.00 |
| **L_GT-ASIS (cm)** | 17.83±2.49 | 18.00 | 12.00-28.00 |
| **L_GT-IT (cm)** | 21.53±2.65 | 22.00 | 14.00-27.00 |
| **L_IT-ASIS (cm)** | 20.08±2.55 | 20.00 | 14.00-25.00 |
| **Total GT-ASIS (cm)** | 17.25±2.29 | 17.50 | 11.00-28.00 |
| **Total GT-IT (cm)** | 21.39±2.41 | 22.00 | 14.00-26.00 |
| **Total IT-ASIS (cm)** | 19.42±2.29 | 19.50 | 13.00-25.00 |

R=Right, L=Left, GT = greater trochanter, ASIS = anterior superior iliac spine, IT = iliac tubercle

**Table 2. Comparison of Muscle, Subcutaneous, and Total Tissue Thicknesses of Four Injection Sites**

| Method | Muscle thickness(mm) | | Subcutaneous fat thickness (mm) | | Total tissue thickness (mm) | |
|---|---|---|---|---|---|---|
| | Mean±SD | P* | Mean ±SD | P* | Mean ±SD | P* |
| **V** | 35.10±7.47 | 0.00 | 31.65±14.26 | 0.00 | 66.76±15.71 | 0.00 |
| **G** | 31.82±8.23 | V>G | 28.32±12.75 | V>G | 60.15±13.49 | V>G |
| **PSIS-T** | 40.64±6.51 | PSIS-T>V | 30.95±12.12 | PSIS-T>G | 71.59±14.08 | PSIS-T>V |
| **ASIS-C** | 40.14±6.99 | ASIS-C>V | 32.02±13.25 | ASIS-C>PSIS-T | 72.16±15.32 | ASIS-C>V |
| | | PSIS-T>G | | ASIS-C>G | | PSIS-T>G |
| | | ASIS-C>G | | | | ASIS-C>G |

* Variance analysis for repeated measurements

**Table 3. Comparison of Muscle, Subcutaneous, and Total Tissue Thicknesses of Four Injection Sites by Gender**

| Thickness (mm) | Methods | Female | Male | t | p |
|---|---|---|---|---|---|
| Muscle | V | 33.80±5.329 | 40.76±11.96 | -2.346 | 0.03 |
| | G | 29.68±6.10 | 41.13±9.89 | -4.574 | 0.00 |
| | PSIS-T | 39.70±5.67 | 44.70±8.40 | -2.973 | 0.00 |
| | ASIS-C | 39.25±5.48 | 44.04±10.85 | -1.770 | 0.09 |
| Subcutaneous fat | V | 34.47±13.18 | 19.41±12.46 | 4.288 | 0.00 |
| | G | 30.79±11.86 | 17.58±11.01 | 4.192 | 0.00 |
| | PSIS-T | 33.45±10.97 | 20.10±11.07 | 4.515 | 0.00 |
| | ASIS-C | 34.67±12.06 | 20.45±12.25 | 4.371 | 0.00 |
| Total | V | 68.27±14.73 | 60.17±18.48 | 1.946 | 0.05 |
| | G | 60.48±13.09 | 58.72±15.46 | 0.484 | 0.63 |
| | PSIS-T | 73.15±13.65 | 64.80±14.32 | 2.254 | 0.02 |
| | ASIS-C | 73.92±14.29 | 64.50±17.65 | 2.344 | 0.02 |

**Table 4. Comparison of Muscle, Subcutaneous, and Total Tissue Thicknesses of Four Injection Sites By BMI**

| Thickness (mm) | Methods | Underweight <18.5 | Normal weight 18.5-24.99 | Slightly overweight* 25< | p** | P*** |
|---|---|---|---|---|---|---|
| Muscle | V | 33.26±3.77 | 34.01±7.70 | 39.80±7.16 | 0.00 | r=0.283 p=0.00 |
| | G | 30.35±5.50 | 31.19±8.47 | 34.82±8.77 | 0.19 | r=0.174 p=0.10 |
| | PSIS-T | 36.21±5.00 | 40.29±6.18 | 44.94±6.17 | 0.00 | r=0.406 p=0.00 |
| | ASIS-C | 37.89±4.47 | 39.28±6.81 | 44.43±7.56 | 0.00 | r=0.298 p=0.00 |
| Subcutaneous fat | V | 21.75±6.90 | 30.41±12.91 | 42.75±15.60 | 0.00 | r=0.451 p=0.00 |
| | G | 19.46±5.62 | 27.15±11.76 | 38.43±13.35 | 0.00 | r=0.457 p=0.00 |
| | PSIS-T | 23.37±6.82 | 29.58±11.31 | 40.75±11.96 | 0.00 | r=0.44 p=0.00 |
| | ASIS-C | 23.53±8.09 | 30.69±12.29 | 42.32±13.38 | 0.00 | r=0.298 p=0.00 |
| Total | V | 55.01±7.34 | 64.42±13.24 | 82.55±15.87 | 0.00 | r=0.545 p=0.00 |
| | G | 49.82±7.63 | 58.35±11.10 | 73.26±14.25 | 0.00 | r=0.538 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | p=0.00 |
| | **PSIS-T** | 59.58±10.19 | 69.87±11.34 | 85.69±13.33 | 0.00 | r=0.570 |
| | | | | | p=0.00 |
| | **ASIS-C** | 69.42±10.44 | 69.97±13.55 | 86.76±13.56 | 0.00 | r=0.514 |
| | | | | | p=0.00 |

* Three participants with a BMI > 30 kg/m$^2$ were moved from the "obese" group to the "mildly obese" group.
** One-way ANOVA *** Pearson's correlation

**Table 5. Comparison of Muscle, Subcutaneous, and Total Tissue Thicknesses of Four Injection Sites by Right and Left Gluteal Regions**

| Thickness (mm) | Methods | Right | Left | t | p |
|---|---|---|---|---|---|
| **Muscle** | **V** | 34.67±8.15 | 35.53±8.09 | -1.289 | 0.20 |
| | **G** | 31.03±8.40 | 32.61±9.14 | -2.448 | 0.01 |
| | **PSIS-T** | 40.97±6.77 | 40.97±6.77 | 1.099 | 0.00 |
| | **ASIS-C** | 40.18±7.39 | 40.10±7.29 | 0.175 | 0.86 |
| **Subcutaneous fat** | **V** | 31.09±14.14 | 32.21±14.59 | -3.037 | 0.00 |
| | **G** | 26.74±12.03 | 29.94±13.89 | -6.023 | 0.00 |
| | **PSIS-T** | 30.79±12.16 | 31.12±12.43 | -0.741 | 0.46 |
| | **ASIS-C** | 31.93±13.53 | 31.12±12.43 | -0.423 | 0.67 |
| **Total** | **V** | 65.77±16.82 | 67.75±15.25 | -2.833 | 0.00 |
| | **G** | 57.78±14.36 | 62.52±13.65 | -6.001 | 0.00 |
| | **PSIS-T** | 71.77±14.38 | 71.42±14.51 | 0.520 | 0.60 |
| | **ASIS-C** | 72.12±15.57 | 72.20±15.51 | -0.151 | 0.88 |

## Discussion

This study investigated the muscle, subcutaneous, and total tissue thicknesses of injection sites determined by four methods (V, G, PSIS-T, and ASIS-C) and analyzed the potential of the ASIS-C method to identify a safe site for IM injections. The study also provided insight into the right needle sizes for IM injections.

The safe injection site and needle size depend on the gender and BMI (Strohfus et al., 2018). Our results showed a significant difference in muscle, subcutaneous, and total tissue thicknesses between the V, G, PSIS-T, and ASIS-C injection sites. The V site had thicker muscle, subcutaneous, and total tissue than the G site ($p<0.05$). Kaya et al. (2015) also found that the V site had greater subcutaneous and total tissue thicknesses than the G site. Therefore, the G method is more reliable than the V method for VG injections (Kaya et al, 2015; Larkin et al., 2018b). However, Larkin et al (2018b) reported that the G injection site had greater muscle and total tissue thicknesses than the V injection site but found no difference in subcutaneous tissue thicknesses between the two sites. The difference in the reported results might be due to the fact that V injection site identification depends on the hand size of the practitioner and the pelvic height of the patient (Kaya et al., 2015; Zimmermann, 2010; Larkin et al., 2018b).

Our results showed that the DG site had greater subcutaneous and total tissue thicknesses than the VG site, as has been

reported by earlier studies (Coskun et al., 2016; Larkin et al. 2017, Masuda et al., 2016). Therefore, the VG site is safer for IM injections than the DG site in terms of subcutaneous tissue thickness, which makes the delivery of medication to the muscle mass easier and more effective.

The subcutaneous tissue thickness of the gluteal site may prevent the needle from reaching the muscle (Larkin et al., 2018a). Our results showed that the DG site had significantly greater subcutaneous thickness than the VG site, indicating that the latter is safer for IM injections than the former. However, the results also showed that the ASIS-C site, which is the subcutaneous tissue layer closest to the VG site, is an alternative site for IM injections in cases where the VG site is hard to identify. The ASIS-C site had greater subcutaneous and total tissue thicknesses than the G site. There was not a significant difference only in subcutaneous tissue thicknesses between the ASIS-C and V sites. This result suggests that the V site can be used to administer IM injections to people with obesity, while the ASIS-C site can be used in cases where the patient cannot position themselves properly or where the nurse cannot identify the injection site due to their hand size. Given the subcutaneous tissue thickness of the DG site, needles larger than 32 mm should be used for IM injections, which makes the ASIS-C site safe and effective.

Research shows that female have greater subcutaneous tissue thickness than men (Kaya et al., 2015; Nisbet, 2006; Zaybak et al., 2007). Our female participants also had significantly greater subcutaneous and total tissue thicknesses in the V site and subcutaneous tissue thicknesses in the G site than males, but there was no significant difference in total tissue thickness in the G site between males and females. Kaya et al. (2015) reported that female had greater subcutaneous and total tissue thicknesses in the V and G site than males. Larkin et al (2018a) also found that female had greater total tissue thickness than men, but the difference was statistically insignificant. Zaybak et al. (2007) reported that female had greater subcutaneous tissue thickness in the VG and DG sites than men. These results indicate that we should take gender into account when choosing the right size of needle for IM injections. Our female participants had a mean subcutaneous tissue thickness of 30.79±11.86 (G site) to 34.67±12.06 (ASIS-C site), while male participants had a mean subcutaneous tissue thickness of 17.58±11.01 (G site) to 20.45±12.25 (ASIS-C site). This result shows that the needle size for IM injections for female and men should be greater than 35 mm and 21 mm, respectively, and that the higher the BMI, the longer the needle should be.

The results showed that the higher the BMI, the greater the V- and G-site subcutaneous and total tissue thicknesses. Kaya et al. (2015) also found that the V site had significantly greater subcutaneous and tissue thicknesses than the G site and that the higher the BMI, the greater the tissue thickness. In our study, BMI had no significant effect on the increase in the G site muscle thickness but was correlated with the other sites. Ozen et al. (2019) also found that the higher the BMI, the greater the subcutaneous tissue thickness. Sakamaki et al (2013) reported that people with a BMI > 21 kg/m$^2$ had greater DG-site subcutaneous and muscle tissue thicknesses than those with a BMI < 21 kg/m$^2$. Zaybak et al. (2007) found that the higher the BMI, the greater the DG-site subcutaneous tissue thickness in men and VG-site subcutaneous tissue thickness in female. These results indicate that we should also take BMI into account when choosing the right size of needle for IM injection. Based on BMI, the needle size for IM injection for obese, normal, and mildly overweight individuals should be at least 24, 30, and 43 mm, respectively.

Coskun et al. (2016) found no statistically significant difference in DG and VG site tissue thickness between the right and left gluteal. Our participants had significantly greater V and G site subcutaneous and total tissue thicknesses and G and PSIS-T site muscle tissue thicknesses on the left gluteal than on the right gluteal. These differences, especially in the V and G sites, might have been because the nurse who had identified the V and G injection sites can use her right hand actively. Right- or left handedness may cause the nurse to identify different IM injection sites on the left and right side. It is, therefore,

recommended that healthcare professionals choose the side on which they can use their active hands to identify safe IM injection sites. Those differences might also have been due to the fact that most people use the right lower extremity.

Studies on the relationship between tissue thickness and IM injection were examined. Larkin et al. (2018b) found that IM injections to the V had a success rate of 57 percent, led to a heightened risk of bone injury in 28 percent of the participants, and hit the subcutaneous tissue in 15 percent of the participants. They also reported that IM injections to the G site had a success rate of 75 percent, led to a heightened risk of bone injury in 10 percent of the participants, and hit the subcutaneous tissue in 15 percent of the participants. They concluded that the G site is safer for IM injections than the V site. Larkin et al. (2017) reported that IM injections to both VG sites with 38 mm needles had a success rate of 98 percent in normal weight individuals, 75 percent in obese female, and 90 percent in men. Kaya et al. (2015) found veins in 6.7 percent of cases. We did not administer IM injections, and therefore, did not assess the success rate. However, we determined the distance between the injection sites and the neurovascular structures and detected arteries in 7.6 percent of the participants but observed nerves in none of the participants. Coskun et al. (2016) also reported that the VG site was farther from the arteries and nerves than the DG site.

**Limitation:** The study had three limitations: (1) participants were recruited from one center, (2) the sample consisted of people of a certain age group, and (3) the sample skewed toward including exclusively female (81.3%).

**Conclusion:** The results indicate that muscle, subcutaneous, and total tissue thicknesses depend on the injection site, gender, and BMI. The results show that the ventrogluteal G site is the safest site for injection. If the ventrogluteal site is unsuitable, the dorsogluteal (anterior superior iliac spine and coccyx_ASIS-C) site is a safe site for injection in terms of subcutaneous tissue thickness, presence of vessels, and distance to the nerve. The ASIS-C is a safe DG injection site in terms of subcutaneous tissue thickness and distance from the neurovascular structures. Female have greater subcutaneous tissue thickness than men, and therefore, the needle size for IM injections in the former and the latter should be greater 35 and 21 mm, respectively. Based on BMI, the needle size for IM injections in obese, normal, and mildly overweight individuals should be at least 24, 30, and 43 mm, respectively.

**Acknowledgements:** We would like to thank all participating in the study.

## References

Berman, A., Snyder, S.J., & Frandsen, G. (2016). *Kozier & Erb's Fundamentals of Nursing Concepts*, Process, and Practice.10th ed. Harlow, Essex Pearson Education Limited, pp. 827-828.

Boyd, A.E., Deford, L.L., Mares, J.E., Leary, C.C., Garris, J.L., Dagohoy, C.G., Boving, V.G., Brook, J.P., Phan, A., & Yao, J.C. (2013). Improving the success rate of gluteal intramuscular injections. *Pancreas,* 42(5), 878–882.

Brown, J., Gillespie, M., & Chard, S. (2015). The dorso-ventro debate: in search of empirical evidence. *British Journal of Nursing*, 24 (22), 1132–1139. doi: 10.12968/bjon.2015.24.22.1132

Cocoman, A., & Murray, J. (2010). Recognizing the evidence and changing practice on injection sites. *British Journal of Nursing*, 19 (18), 1170-1174.

Coskun, H., Kilic, C., & Senture, C. (2016). The evaluation of dorsogluteal and ventrogluteal injection sites: a cadaver study. *Journal of Clinical Nursing*, 25 (7-8), 1112-1118. doi:https://doi.org/10.1111/jocn.13171.

Dinc, L. (2014). Parenteral Drugs. Ed: Atabek AT, Karadag A. Nobel Bookstore, Clinical Practice Skills and Methods. Adana, p: 693-761.

Elgellaie, A., Ashcroft, E., & Larkin, T. A. (2018). Effects of thickness of muscle and subcutaneous fat on efficacy of gluteal intramuscular injection sites. *British Journal of Nursing,* 27(6), 300-305.

Floyd, S., & Meyer, A. (2007). Intramuscular injections--what's best practice? Nursing *New Zeland,* 13(6), 20-22.

Greenway, K. (2004). Using theventrogluteal site forintramuscularinjection. *Nursing Standard,* 18 (25), 39-42.

Greenway, K. (2014). Rituals in nursing: intramuscular injections. *Journal of Clinical Nursing*, 23, 3583- 3588.

Gulnar, E., & Caliskan, N. (2014). Determination of Knowledge Level of Nurses Regarding Intramuscular Injection Administration To Ventrogluteal Site. *Dokuz Eylul University*

*Faculty of Nursing Electronics Journal*, 7(2),70-77. (In Turkish).

Gunes, Y. U., Zaybak, A., & Tamsel, S. (2008). The Examination of the Reliability of the Method Used in Identifying of Ventrogluteal Site. *Institute of Health Sciences Journal*, 12(2), 1-8.

Hopkins, U., & Arias C. (2013). Large-volume IM injections: a review of best practices. https://www.oncologynurseadvisor.com/home/hot-topics/chemotherapy/large-volume-im-injections-%e2%80%a8a-review-of-best-practices/8/ [Accessed April, 4, 2020].

Hunter, J. (2008). Intramuscular injection techniques. *Nursing Standard*. 22(24).35-40.

Karabacak, B.G. (2010). Parenteral Drug Applications. In: Clinical Skills; Evaluation of Health, Patient Care and Follow-up. Eds: Sabuncu N, Ay FA. Nobel Medicine Bookstores, Istanbul, pp.250-300

Kaya, N., Salmaslioglu, A., Terzi, B., Turan, N., & Acunas, B. (2015). The reliability of site determination methods in ventrogluteal area injection: A cross-sectional study. *International Journal of Nursing Studies*, 52(1), 355-360.

Larkin, T. A., Ashcroft, E., Elgellaie, A., & Hickey, B. A, (2017). Ventrogluteal versus dorsogluteal site selection: a cross-sectional study of muscle and subcutaneous fat thicknesses and an algorithm incorporating demographic and anthropometric data to predict injection outcome. *International Journal of Nursing Studies*, 71, 1-7.

Larkin, T. A., Ashcroft, E., Hickey, B. A., & Elgellaie, A. (2018a). Influence of gender, BMI and body shape on theoretical injection outcome at the ventrogluteal and dorsogluteal sites. *Journal of Clinical Nursing*, 27(1-2), e242-e250.

Larkin, T. A., Elgellaie, A., & Ashcroft, E. (2018b). Comparison of the G and V methods for ventrogluteal site identification: Muscle and subcutaneous fat thicknesses and considerations for successful intramuscular injection. International Journal of Mental Health Nursing, 27(2), 631-641.

Legrand, G., Guiguet-Auclair, C., Viennet, H., Aumeran, C., Reynaud, D., Badrikian, L., & Debost-Legrand, A. (2019). Nurses' practices in the preparation and administration of intramuscular injections in mental health: A cross-sectional study. *Journal of Clinical Nursing,* 28(17-18), 3310-3317.

Malkin, B. (2008). Are techniques used for intramuscular injection based on research evidence? Nursing Times. 104, 48-51.

Masuda, S., Yasuhara, Y., Tanioka, T., Atsuta, A., Motoki, K., Takase, K., & Locsin, R. C. (2016). Comparison of gluteal muscle intramuscular injection sites of Japanese healthy subjects: considerations for optimal insertion of injection needle length. *Open Journal of Psychiatry*, 6(2), 203-212.

Meneses, A.S. (2007). A proposal for a geometrical delimitation model for ventro-gluteal injection). *Rev. Bras. Enferm*, 60, 552–558.

Nicoll, L.H., & Hesby, A. (2002). Intramuscularinjection: an integrative research review and guideline for evidence-based practice. *Applied Nursing Research*, 15(3), 149-62. doi: 10.1053/apnr.2002.34142.

Nisbet, A. C. (2006). Intramuscular gluteal injections in the increasingly obese population: Retrospective study. *British Medical Journal*. 332, 637–638.

Ozen, O., Gunaydin, M., Tosun, A., Coskun, Z. U., Aytekin, K., & Takir, S. (2019). Assessment rate of true dorsogluteal intramuscular drug injection using ultrasonography. *Pakistan Journal of Medical Sciences*, 35(4), 1132.

Potter, P.A., Perry, A.G., Stockert, P., & Hall, A. (2017). *Medication administration*. In: Fundamental of Nursing. 9th ed. Elsevier: St. Louis, pp. 670-674.

Regulation Amending the Regulation on Nursing. [Internet]. The Official Gazette. [cited 2020 May 09]. Available from: http://www.resmigazete.gov.tr/eskiler/2011/04/20110419-5.htm

Sabuncu, N. (2008). Principles and Practices in Nursing Care. 2nd Edition. Ankara, Alter Publishing.

Sakamaki, S., Yasuhara, Y., Motoki, K., Takase, K., Tanioka, T., & Locsin, R. (2013). The relationship between body mass index, thickness of subcutaneous fat, and the gluteus muscle as the intramuscular injection site. *Health,* 5(9),1443-1448.

Sakic, B., Milutinovic, D., & Simin, D. (2012). An assessment of intramuscular injection practices among nursing students and nurses in hospital settings: is it evidence-based?. *South Eastern Europe Health Sciences Journal*, 2(2), 92-118.

Small, S. P. (2004). Preventing sciatic nerve injury from intramuscular injections: literature review. *Journal of Advanced Nursing*, 47(3), 287-296.

Strohfus, P. K., Paugh, O., Tindell, C., & Molina-Shaver, P. (2018). Evidence calls for practice change in intramuscular injection techniques. *Journal Nursing Education Practice*, 8(2), 83-92.

Turan, N., Aydın, G. O., Kaya, N. (2019). Selection of Site for Administration of Intramuscular Injection to Adult Patients by Nurses: A Cross-Sectional Study. *Journal of Health Science of Kocaeli University*, 5(3), 134-140. (In Turkish).

Walsh, L., & Brophy, K. (2011). Staff nurses' sites of choice for administering intramuscular injections to adult patients in the acute care setting. *Journal of Advanced Nursing*, 67(5), 1034-1040.

Wynaden, D., Tohotoa, J., Omari, O.A., Happell, B., Heslop, K., Barr, L., & Sounrinathan, V. (2015). Administering intramuscular injections: how does research translate into practice over time in the mental health setting. *Nurse Education Today*, 35 (4), 620-624.

Zaybak, A,, Gunes, U.Y., Tamsel, S., Khorshid, L., & Eser, I. (2007). Does obesity prevent the needle from reaching muscle in intramuscular injections? *Journal of Advanced Nursing*, 8(6), 552-556.

Zimmermann, P. G. (2010). Revisiting IM injections: The ventrogluteal site is the safest for intramuscular injections. *American Journal of Nursing*, 110, 60–61.