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UNIVERSITY OF ALBERTA

ASSESSING INTRAMUSCULAR INJECTION: TECHNIQUE, SITE, AND PAIN PERCEPTION

by

MAUREEN MCQUEEN

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF NURSING

FACULTY OF NURSING

EDMONTON, ALBERTA

SPRING, 1990

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Abstract

Intramuscular injections are considered by both nurses and patients to be painful. Of the available intramuscular injection sites, use of some sites seems to cause more pain than others. Two of the sites which may be different in sensitivity are the dorsogluteal and the ventrogluteal. Therefore, a 2x2x2 mixed factorial study was designed and conducted to compare pain experienced following dorsogluteal and ventrogluteal injections. The subjects who took part in this study were patients on medical or surgical units in a large teaching and research hospital. In order to participate, subjects were required to have two or more intramuscular injections of meperidine hydrochloride. The between group independent variable was injection technique (z-track, standard) and the within subject independent variables were injection site (ventrogluteal, dorsogluteal) and time (time I, time II). Subjects received two injections, one at each of the two injection sites, and reported their pain immediately and about four hours later. Pain was assessed with a visual analog scale. The reported pain experienced with a ventrogluteal intramuscular injection was significantly less than that of a dorsogluteal intramuscular injection. No significant differences in reported pain were found for z-track and standard techniques. Pain reported from all intramuscular injections at the second time interval (approximately four hours after injection) was significantly less than pain reported at the first time interval (immediately after injection). These results suggest that

nurses should employ the ventrogluteal site in order to reduce the pain associated with intramuscular injection.

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Assessing Intramuscular Injection: Technique, Site, and Pain Perception

Maureen McQueen

University of Alberta

Intramuscular injections are often used as the route for administering medications. However, this procedure usually produces pain and the pain may last for some time after the injection has been given. In some cases, the pain of the injection may have long term effects such as evoking anxiety and avoidance behavior whenever injections are needed. To avoid these long term effects and to increase patient comfort during injections, nurses must seek ways to decrease or limit the pain associated with intramuscular injection.

A review of the literature (See Appendix A) determined that several factors are known to be associated with pain from intramuscular injection. These factors include: the techniques of intramuscular injection; type of medication solution injected; duration of injection of fluid; positioning for intramuscular injection; and choice of site for intramuscular injection.

Z-track or standard injection techniques may be used in giving intramuscular injections. Z-track injection technique requires that the overlying tissues be laterally displaced prior to the injection, and held there during and after the injection. Use of the z-track method is advocated to prevent the leakage of medication into the subcutaneous tissue thereby reducing pain (Keen, 1986; Zelman, 1961). Standard injection technique requires that the tissue be stretched but not laterally displaced. In a comparison of z-track and standard injection techniques

for the ventrogluteal site, the z-track technique was found to result in lower incidence and severity of discomfort and lesions at the injection site several hours after the injection. There were no differences in discomfort for the two techniques immediately after the injections (Keen, 1986). These findings support the theory that the z-track technique may reduce discomfort by preventing leakage of medication into the subcutaneous tissue.

Some medication solutions are more irritating to both the subcutaneous and muscle tissue when injected than others (Kruszewski, Lang, & Johnson, 1979). Factors such as chemical composition of the drug, viscosity of the solution, and the amount of solution that is required to administer the prescribed dose, can all contribute to the degree of pain felt on injection.

There is agreement in the literature that the medication should be injected slowly, thereby decreasing the pressure and the rapid distention of the muscle tissue which can result in undue pain and discomfort (Perez, 1984; Travell, 1955; Zelman, 1961). In a study which measured the duration of injection time and the relationship to pain, it was reported that injection of medication lasting about 20 seconds compared with injection of medication lasting about five seconds resulted in less pain (Perez, 1984).

The position of the patient during injection is another factor to be considered. When a dorsogluteal injection site is used the patient should lie prone with toes pointed inward. This position produces internal

rotation of the hips and relaxation of the gluteal muscles, resulting in a less painful injection (Kruszewski, et al., 1979; Rettig & Southby, 1982; Zelman, 1961). In a study conducted to compare prone and side-lying positions, for the dorsogluteal site, there was no difference in discomfort for the two positions when the toes were pointed inward and the femurs were internally rotated (Rettig & Southby, 1982).

A number of sites may be chosen for giving an intramuscular injection, but a gluteal muscle site seems to be preferred. Likely the preference for this site is related to the thickness and lesser sensitivity of the muscle, which allows for deep injection of medication (Zelman, 1961). However, two gluteal sites (dorsal and ventral) may be used. Some clinical reports suggest that the ventrogluteal site may produce less pain (Feldman, 1987; Zelman, 1961). Reasons for this may be that the ventrogluteal site provides a greater thickness of muscle (consisting of both the gluteus medius and minimus), contains no significant penetrating nerves or blood vessels, and is covered by a thinner layer of subcutaneous tissue than the dorsogluteal site. In most of the research about injection and technique, only the dorsogluteal site has been used (Kruszewski et al., 1979; Rettig & Southby, 1982; Zelman, 1961).

Intramuscular injection, for the purpose of administering medication, is a long-standing and common therapeutic technique performed by nurses. However, it is not clear which of two gluteal injection sites is less painful, nor is it clear what technique would be preferable for each of the

sites. The purpose of this study was to compare the pain of intramuscular injection into the ventrogluteal site and the dorsogluteal site utilizing the techniques of z-track and standard intramuscular injection.

Method

Sample

The sample was selected from among male and female adult in-patients on medical and surgical units of a large teaching and research hospital. The first 32 patients who met the study selection criteria and who voluntarily agreed to participate were included. To be selected for this study, subjects were required to be age 18 - 65 years, alert, oriented, able to speak and read English, and have been prescribed intramuscular injections of meperidine hydrochloride. Only subjects who were likely to receive two or more injections per day were considered for participation in this study. Individuals who were extremely obese or emaciated, who had a history of neurologic dysfunction, or who had any interfering illness, such as generalized or localized edema, were excluded from participation in this study.

Instruments

Pain was measured on a subjective visual analog scale (VAS) (Pilowsky & Bond, 1969; Pilowsky & Kaufman, 1965) (See Appendix B). The scale consisted of a ten centimeter line with the descriptor "no pain" at the left end and "as painful as it could be" at the right end. Subjects rated their pain by making a pencil mark on the line. A "pain score" was obtained by measuring the distance from the left end of the line to where

the pencil mark intercepted the line. All measurements were taken with the same ruler and recorded to the millimeter.

The VAS is considered to be a reliable and valid paper and pencil instrument for measuring pain intensity (Huskisson, 1974; Kremer, et al., 1981). Some advantages of the VAS are: pain estimates are reliable over time (Huskisson, 1974; Revill, Robinson, Rosen, & Hogg, 1976), variance resulting from psychomotor factors is small (Revill, et al., 1976), distribution of pain intensity estimates are uniform (Huskisson, 1974), and the individual is not confined to evaluating their pain with numerical or word descriptors (Levin, 1982).

Procedure

In this study two injection sites and two injection techniques were used. Subjects were exposed to only one injection technique but to two injection sites. All injections were given by the researcher. The procedures for the identification of injection sites and techniques for injection follow.

Ventrogluteal intramuscular injection: The ventrogluteal site was located by positioning the subject on the appropriate side, with the upper leg flexed at the hip and knee, and placed in front of the lower leg. The anterior superior iliac spine was palpated and the tip of the index finger was placed on it. With the hand resting on the hip and the palm over the greater trochanter and the fingers pointing toward the head, the index and middle fingers were spread as far apart as possible to form a 'V'. The injection was given between the index and middle fingers and below

the iliac crest (University of Alberta Hospitals, 1985). The ventrogluteal intramuscular injection site is diagrammed in Appendix C.

Dorsogluteal intramuscular injection: The dorsogluteal site was located by positioning the subject on the appropriate side with upper leg flexed at the hip and knee, and placed in front of the lower leg. The posterior superior iliac spine was palpated and an imaginary line to the greater trochanter of the femur was drawn. The injection was then given lateral and superior to this line and two or three inches below the crest of the ilium (University of Alberta Hospitals, 1985). The dorsogluteal intramuscular injection site is diagrammed in Appendix D.

Standard intramuscular injection: This technique included use of aseptic sterile technique and a #22 gauge, 1 - 1 1/2 inch needle, with no air bubble in the syringe. A site free of pain and nodules on palpation was chosen. The tissue was stretched with the non-dominant hand. The needle was inserted at a 90 degree angle with a quick thrust deep into the muscle. The plunger of the syringe was pulled back to check for blood in the syringe. The medication was injected slowly, over approximately 20 seconds, and the needle was removed quickly along the line of insertion. The site was then massaged for a minimum of 30 seconds.

Z-track intramuscular injection: This technique was identical to the standard intramuscular injection technique except that the skin and subcutaneous tissue were displaced approximately 2.5 to 3.5 cm laterally prior to site cleansing and needle insertion. The lateral displacement of

the subcutaneous tissue was released ten seconds following needle withdrawal.

Patients were evaluated for admission to the study according to the specified criteria. The study was described and informed consent obtained. Before assigning subjects to groups, the investigator explained the procedures of the study, and trained the subject in the use of the pain scale. This created a partial blind in the study, whereby the subject's experimental condition was unknown to the researcher until just prior to presentation of the assigned treatment (Christensen,1985). Subjects were then randomly assigned to one of two groups with the restriction that equal proportions of males and females be assigned to each group. One group was assigned to receive the z-track technique and the other group received the standard technique. Subjects in the two groups received two injections, with their assigned technique, one at each gluteal site (ventrogluteal, dorsogluteal), and separated by a period of time. The timing of the two injections was based on the needs of each subject. The same dose and volume of the prescribed medication, meperidine hydrochloride, was administered for both injections. The dosage of meperidine hydrochloride given ranged from 75 to 125 mg, resulting in the volume of fluid injected being 1 cc or 2 cc. The drug was administered at room temperature.

The order in which subjects received injection to the ventrogluteal site or the dorsogluteal site was determined through random counterbalancing. Both the injections were given in the same side

unless contra-indicated by any one of the following factors: the subject reported the site painful to touch or there were nodules or lesions present at the site.

Immediately following each injection the researcher left the room so that the subject could report pain (time I) using the VAS without influence from the researcher. The subject then placed the completed pain scale in an envelope which was collected by either the investigator or a staff member. Using the same data recording method, subjects also reported pain at the injection site at the time their next injection was due (time II), approximately three to four hours after each injection.

Design

A 2 x 2 x 2 mixed factorial design was used in this study (See Appendix E). The main independent variable of interest was the within subject variable injection site (ventrogluteal, dorsogluteal). The second independent variable was injection technique (z-track, standard) and this was a between group variable. In addition, two repeated measures of pain were obtained at two time intervals after the injection (time I, time II) which produced a third independent variable (also within subject). The dependent variable was self-reported pain.

Hypotheses

Although this factorial design permitted the testing of three main effect hypotheses and four interaction hypotheses (Christensen, 1985), two hypotheses were of interest in this investigation.

1. There will be less pain from an intramuscular injection in the ventrogluteal site than from an intramuscular injection in the dorsogluteal site (main effect of site).
2. There will be less pain from a Z-track intramuscular injection than from a standard intramuscular injection at time II (interaction of time and technique).

Results

Sample Characteristics

A total of seventy-four subjects were approached to participate in the study. Two subjects declined and seventy-two (72) consented to participate in the study. Of the seventy-two subjects who volunteered thirty-seven were unable to participate in the study. Eighteen did not require analgesics often enough to be included, seven had analgesics other than meperidine hydrochloride prescribed, four required dimenhydrinate to be given with the meperidine hydrochloride, four were prescribed oral analgesics, two were discharged prior to surgery, and two were not required to participate due to the gender requirements of the study having been met. Three other subjects started to participate in the study but were dropped part way through because one required dimenhydrinate, another exhibited signs and symptoms of an adverse reaction and a third did not require analgesia frequently enough.

The thirty-two remaining subjects, sixteen female and sixteen male, completed the study. Twenty-five of the subjects were post-operative surgical patients and seven were medical patients. All but two subjects

received both intramuscular injections in the same side. The characteristics of the subjects are described in Table 1. The subjects ranged in age from 20 to 62 years with a mean age of 37 years (standard deviation (SD) 11 years). Height ranged from 155 cm to 187 cm, with a mean height of 169 cm, (SD 8 cm). Weight ranged from 45 kg to 120 kg, with a mean weight of 75 kg, (SD 19 kg). Body mass index (BMI), a tool measuring body weight relative to body height, was determined by dividing weight by squared height (Health and Welfare Canada, 1988). The BMI ranged from 16.3 to 39.1 with a mean of 26.19, (SD 6.34). BMI was statistically controlled in this study through use of analysis of covariance in tests of hypotheses. The overall outcome measure, pain, ranged from 0 to 7.8 with a mean of 1.48, (SD 1.84). Analysis of variance (ANOVA) was used to compare subjects' age, height, weight, and BMI by group (z-track, standard). No significant differences were found. ANOVA was also used to compare sex with reported pain, again there were no significant differences.

Effect of Site, Technique, and Time on Reported Pain Scores

Analysis of covariance was used to compare pain scores for site, technique, and time, (BMI as the covariate). The pain experienced with a ventrogluteal intramuscular injection was significantly different from that of a dorsogluteal intramuscular injection (Table 2: $F = 9.57$, $p = 0.004$). As shown in Table 3, the mean pain reported for ventrogluteal intramuscular injection was 1.121, and for dorsogluteal intramuscular injection was 1.836. Time was also significant ($F= 22.07$, $p < 0.001$).

Table 1

Characteristics of the Study Sample

	Mean	Variance	St. Dev.	St. Er.	Range
Age	37	117.47	10.84	1.92	20.0 - 62.0
Height in cm	168.89	65.53	8.09	1.4	155.0 - 187.0
Weight in Kg	74.69	347.45	18.64	3.29	45.0 - 120.0
BMI*	26.19	40.2	6.34	1.12	16.3 - 39.1
Outcome Measure	1.48	3.38	1.84	0.16	0 - 7.8

* Body mass index (BMI), a tool measuring body weight relative to body height, determined by calculating weight in kilograms divided by height in meters squared.

Table 2

Analysis Covariance (ANCOVA) Summary Table

	SS	DF	MS	F	Sig of F
Technique	2.89	1	2.89	.01	.942
Time	6612.50	1	6612.50	22.07	<.001
Site	1638.78	1	1638.78	9.57	.004
Site by Time	22.78	1	22.78	.21	.648
Technique by Site	306.28	1	306.28	1.79	.191
Technique by Time	45.12	1	45.12	.15	.701
Technique by Site by Time	148.78	1	148.78	1.39	.248

Table 3

Summary of Mean Pain Scores to Corresponding Site and Time

	Time*		
Site**	Time 1	Time 2	Overall Mean
Ventrogluteal	1.797	0.444	1.121
Dorsogluteal	2.597	1.075	1.836
Overall Mean	2.197	0.760	1.478

*Significant at $p < .001$

**Significant at p .004

The mean pain score was greater for time I, (Table 3: mean= 2.197), compared to time II (mean= 0.760).

The interaction of time and site was not significant. The exact time at which subjects reported on the VAS was not recorded. However, seventeen subjects received the two injections approximately 3 to 3.5 hours apart, eleven subjects received the two injections approximately 4 to 4.5 hours apart, and the remaining four subjects received the two injections approximately 5 to 5.5 hours apart. Hence, the period of time between the two measures ranged from approximately three to four hours for the majority of subjects.

Furthermore, the interaction of site and technique was not significant. The mean pain scores corresponding to site and technique are summarized in Table 4. The interactions of (1) technique and time, and (2) technique, time, and site were not significant. The mean pain scores corresponding to site, technique and time are summarized in Table 5.

Discussion

In this study, it was determined that intramuscular injections given at the ventrogluteal site were significantly less painful than intramuscular injections given at the dorsogluteal site. Therefore, Hypothesis I, that subjects would report less pain from an intramuscular injection in the ventrogluteal site than from an intramuscular injection in the dorsogluteal site, was supported. Examination of mean pain scores corresponding to site and time (Table 3) indicates that reported pain from intramuscular injection in either site was mild. Also the difference in pain between the

Table 4

Summary of Mean Pain Scores to Corresponding Site and Technique

	Site**		
Technique	Ventrogluteal	Dorsogluteal	Overall Mean
Z-track	0.963	1.988	1.475
Standard	1.278	1.685	1.481
Overall Mean	1.121	1.836	1.478

**Significant at p .004

Table 5

Summary of Mean Pain Scores to Corresponding Site**Technique and Time*

	Ventrogluteal Site		Dorsogluteal Site	
Technique	Time I	Time II	Time I	Time II
Z-track	1.688	0.238	2.581	1.394
Standard	1.906	0.65	2.613	0.756
Overall Mean	1.797	0.444	2.597	1.075

*Significant at $p < .001$

**Significant at $p .004$

two sites was not large in clinical terms. This finding could give rise to the question about whether or not there is any clinical value in choosing one site over the other. Nurses should always seek to administer therapeutic procedures in a manner which causes the patient the least amounts of pain. Therefore, the ventrogluteal site is preferred over the dorsogluteal site.

Pain reduced significantly over time following intramuscular injection. This was an expected outcome. The external stimuli, of needle insertion and injection of fluid, which contribute to the pain associated with intramuscular injection, had occurred 3 to 4 hours earlier, allowing some recovery. Hence, the pain reported at time II was less than that reported at time I.

Hypothesis II, that subjects would report less pain from a z-track intramuscular injection than from a standard intramuscular injection at time II, was not supported. One possible explanation is that the sample size of 16 for the between group comparison was small in this study resulting in too little power to detect significant differences.

Another explanation is that the time II pain measure occurred too soon to detect significant effects. Keen (1986) using only the ventrogluteal site reported that there was no difference in discomfort for the two techniques immediately after the injection or 2.5 to 5 hours after. However in that study the z-track technique resulted in less discomfort than the standard injection technique when assessed later during the evening. The specific time for the measure was not reported.

The main effect of technique (z-track, standard) was not significant. Although subjects were not informed as to which technique, z-track or standard, was being utilized, a number of subjects commented on various components that they noted about the technique used by the researcher. The majority of comments were in relation to the duration of time (20 seconds) over which the medication was given. All subjects who commented on this factor noted that the researcher injected the medication more slowly. Some subjects indicated this procedure made the intramuscular injection less painful. Some subjects also commented on the time the researcher spent palpating bony prominences to locate sites, indicating that this was not something that had occurred with previous injections. Others commented on the amount of time, over 30 seconds, spent massaging the site following the intramuscular injection, indicating it helped to decrease the amount of pain felt from the injection.

The interaction of site (ventrogluteal, dorsogluteal) with time was not significant and power may not have been adequate for this analysis. It may also be that the time interval between time I and time II, of approximately three to four hours, was too short to contribute to a significant interaction. The dorsogluteal site is covered with larger amounts of subcutaneous tissue than the ventrogluteal site, thereby increasing the chance of injecting into the subcutaneous tissue. This may result in poor absorption of the medication and increased pain at the dorsogluteal site as time goes by. That is, discomfort between the injection sites may increase over a much longer time period. A

longitudinal study assessing intramuscular injection site discomfort 3 to 5 days following would provide valuable information regarding long term intramuscular injection site discomfort.

Subjects' apprehensiveness toward intramuscular injections may also be an influencing factor on reported pain. It was assumed that individuals who were extremely apprehensive about intramuscular injections did not consent to participate. Inasmuch as variables such as anxiety were controlled by utilization of a within subject design and counterbalancing, it would not be expected that anxiety would differ across site and technique. Further, as the majority of subjects at time II were about to receive another injection, anxiety would not be expected to differ across time.

The exact time at which subjects reported time II pain at the injection site was not recorded. Hence, it was not possible to use analysis covariance to statistically control for time in this study.

The interaction of technique (z-track, standard) with site (ventrogluteal, dorsogluteal) was not significant. Adding the factor of time to the interaction of technique with site was also not significant. Again power may not have been adequate for the analysis to detect significant differences.

It may have been appropriate to include sex in the statistical analysis (site by time by technique by sex). However, because of the small between group sample size, power is low in this study and adding another factor to the analysis only further increases the risk of a type II

error. Breaking down the data to compare males and females on pain at time I and time II following each injection would increase the risk of type I error and is therefore not recommended.

Experimenter Bias

The importance of conducting nursing studies in the clinical setting versus the controlled confines of a laboratory cannot be over emphasized, as it is within the clinical setting that the findings will be most congruent with patient situations. In any clinical study it is impossible to control the many variables that may effect the outcome. A researcher can only attempt to be as consistent as possible within the inconsistency of the clinical setting. In this study the following steps were taken to reduce experimenter bias: 1) the researcher presented the study to potential subjects through use of a memorized introduction, 2) all introductions and training in use of the VAS were done prior to subjects being assigned to experimental groups, 3) subjects were asked during the introduction not to discuss the study with the researcher until they had completed the study, 4) intramuscular injections were given using the same techniques, and with the thought in mind to cause the patient as little pain as possible with each injection, 5) the VAS was completed by the subject and placed in a sealable envelope with the researcher out of the room, 6) all the VAS were measured using the same ruler, and 7) no analysis of the data was done until all the subjects had completed the study.

Implications for Nursing

This research study was relevant for clinical nursing practice, as the results have indicated that nurses can decrease the amount of pain their patients experience during and following intramuscular injection. Although not commonly used, the ventrogluteal site is a better choice for intramuscular injection of meperidine hydrochloride in adult medical-surgical patients than the dorsogluteal site. The major advantages of the ventrogluteal site are: 1) it can be safely located through palpation of bony prominences when patients are in a variety of positions, such as side-lying, prone, or supine position, 2) patients do not have to be moved as much to position them for injection, 3) it is more comfortable for patients as they do not have to lie on the site, 4) it is covered with less subcutaneous tissue than the dorsogluteal site, resulting in an intramuscular injection given deeper into the muscle, 5) it contains fewer major nerves and blood vessels, hence is a safer site, and 6) subjects have less pain following intramuscular injection of meperidine hydrochloride into the ventrogluteal site than the dorsogluteal site. Nurses, nurse educators, and student nurses should expand their nursing practice skills to include the use of the ventrogluteal site for intramuscular injection thereby causing their patients less pain.

It was observed by this researcher that some puncture marks, from previous dorsogluteal injections, were level with the iliac crest. The height of such puncture marks suggests poor choice of site location. Education of nursing personnel, about site assessment, location, and

choice should be provided. In discussion of this study with other nurses many indicated they used the dorsogluteal site exclusively because it was the way they had been taught and they felt uncomfortable with their ability to safely use alternate sites.

Implications for Future Research

Given the results of this study, further research is indicated. Exploration of the pain experienced from intramuscular injection, regarding both site (ventrogluteal, dorsogluteal) and technique (z-track, standard), needs to be attempted with a wide variety of nurses administering medications other than meperidine hydrochloride. It is not known whether a number of different nurses using the same injection technique and the same medication would produce similar pain scores or not. Pain scores could vary greatly with intramuscular injection of different medications. One site may be less painful than another for particular medications. Also research on intramuscular injection technique (z-track, standard) is inconclusive. Continued research comparing technique, site, and medication with a larger sample size is required.

Research of intramuscular injections should be expanded to compare pain experienced at all intramuscular injection sites (gluteal, deltoid, vastus lateralis). The data generated from such a study could provide information which would allow nurses to choose alternate sites for intramuscular injection and perhaps to begin using a rotational system for intramuscular injection. A comparison of intramuscular injection site

with perception of overall pain relief should also be explored.

Further research of the pain experienced from intramuscular injection will serve to validate nursing knowledge with regard to the common therapeutic technique of intramuscular injection.

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Appendix A

A Review of the Literature on Intramuscular Injection: Technique, Site, and Pain

Table of Contents

A Review of The Literature on Intramuscular Injection: Technique, Site, and Pain

The purpose of this paper is to review the literature on intramuscular injection and the related pain or discomfort that is experienced by the individual receiving one. Intramuscular injection, for the purpose of this paper, is defined as the injection of medication into a muscle using a needle and syringe. The literature concerning intramuscular injection will be discussed according to the five main themes which emerged: techniques of intramuscular injection; type of medication solution injected; duration of injection of fluid; positioning for intramuscular injection; and choice of site for intramuscular injection, dorsogluteal or ventrogluteal. A description of the anatomy of the gluteal region, the dorsogluteal site, and the ventrogluteal site will be given, and a brief overview of pain and its' measurement will be discussed. Pain, for the purpose of this paper, is defined as the individual's subjective report of the degree of pain experienced from the external stimulation of an intramuscular injection.

Techniques of Intramuscular Injection

The nurse is responsible for utilizing a safe and effective technique when administering intramuscular injections, thereby reducing complications, pain, and discomfort that the patient may incur (Geolot & McKinney, 1975; Jerrett, 1983; McConnell, 1982; Pitel & Wemett, 1964; Shallowhorn, 1954). There is consensus in the literature that it is the responsibility of the nurse to prepare the patient psychologically prior to

administering intramuscular injections. There is also agreement that intramuscular injection is a procedure requiring aseptic technique. Sterility of the needle, the hub of the syringe, and the solution to be injected must always be maintained. Also, the skin at the injection site must be cleansed prior to giving the injection with an antiseptic such as ethyl alcohol or betadine (McConnell, 1982; Pitel & Wemett, 1964; Shallowhorn, 1954; Shepherd & Swearington,1984).

There is also consensus that following insertion of the needle, the plunger of the syringe must be aspirated to check for blood in the syringe (Geolot & McKinney, 1964; McConnell, 1982; Pitel & Wemett, 1964; Shallowhorn, 1954; Shepherd & Swearington, 1984). However, there is varying opinion as to what action should be taken following aspiration of blood into the syringe. Several procedures have been recommended: (1) withdraw the needle immediately, replace it, and reinsert it approximately half an inch away from the original site (McConnell, 1982; Sutton 1969), (2) remove the needle and reinsert it a short distance away, without changing needles prior to reinsertion (Shallowhorn, 1954), (3) withdraw the needle a short distance and then redirect it into a different area of the muscle (Pitel & Wemett, 1964), (4) use a new syringe with fresh medication, as blood in the syringe may alter dosage and absorption of the medication (Sutton, 1969; University of Alberta Hospitals, 1985).

The length and gauge of the needle that should be utilized with adults varies. The suggested range for the length of the needle is from

one to three inches, dependent on the tissues to be injected and the weight of the person. One suggestion is to simply use a long needle when the individual is obese and a short needle when the individual is thin. A short needle being 1 to 1 1/2 inches (Sutton, 1969). A more informative method is to use a needle that is at least 2 inches long for individuals weighing 200 pounds (91kg) or more, and a 11/4 to 11/2 inch needle for individuals 100 pounds (46kg) or more (Shepherd & Swearington, 1984).

Pain from intramuscular injection may be differentially associated with the two basic injection techniques, referred to as standard intramuscular injection and z-track intramuscular injection (Keen, 1986; Zelman, 1961). A standard intramuscular injection is a deft wrist-action stroke, a thrust or dart that advances the needle rapidly into the muscle in a perpendicular or 90 degree angle, with the skin stretched but not laterally displaced prior to insertion of the needle (McConnell, 1982; Shallowhorn, 1954). A z-track intramuscular injection is identical to a standard injection except the subcutaneous tissue is laterally displaced 2.5 - 3.5 cm prior to needle insertion and held until 10 seconds after needle withdrawal. The z-track method is thought to create an indirect or zig - zag path between the muscle and the subcutaneous tissue, thereby prohibiting the back flow of medication out of the muscle into the subcutaneous tissue, thus reducing the pain which results from irritating medication leakage into the subcutaneous tissue (Keen, 1986; Zelman, 1961).

Support for this theory is found in a comparative study of z-track and standard injection techniques for the ventrogluteal site. The z-track technique was found to result in lower incidence and severity of discomfort and lesions at the injection site several hours after the injection. There were no differences in discomfort for the two techniques immediately after the injections or at one treatment interval post-injection, which was reported as a range of 2.5 to 5 hours (Keen, 1986).

A controversial issue about injection technique is whether or not a small air bubble should be drawn into the syringe prior to injection. The rationale is to clear the injected medication from the needle ensuring that an accurate dose is received while decreasing the chance of pain and abscess from seepage of the medication at the injection site (Geolot & McKinney, 1975; McConnell, 1982; Shepherd & Swearington, 1984; Sutton, 1969).

Others question the safety of this practice, noting that syringe calibrations are rated to deliver the prescribed dose and that medication left in the syringe hub and the needle is not part of the syringe barrel calibration. If the nurse does not account for this dead-space volume the patient will receive more than the prescribed amount of medication (Chaplin, Shull, & Welk,1985). There is also no scientific basis for the claim that an air bubble reduces pain or prevents leakage for all intramuscular injections. Hence, the best method to prevent leakage is to utilize the z-track method of injection without an air bubble (Chaplin et al., 1985).

Type of Medication Solution Injected

Pain from intramuscular injection is affected by the type of medication solution injected. The degree of irritation seems to depend on the chemical properties, acidity - alkalinity, and hypertonicity - hypotonicity of the medication. Injections with isotonic buffered solutions, such as morphine sulfate or meperidine hydrochloride, are less irritating to the subcutaneous tissue than injections with a more irritating solution such as diazepam (Goodman & Gilman, 1980; Kruszewski, Lang, & Johnson, 1979; Travell, 1955). Injections with diazepam are reported to result in higher mean discomfort scores than injections with narcotic analgesics (Kruszewski, et al., 1979).

Experiments with hypertonic and hypotonic saline injections into gluteal muscle have resulted in significant differences in pain experienced (Wolff & Jarvik, 1963). Deep somatic pain resulting from injections with hypertonic saline was reported to be a poorly localized, dull ache, of long lasting latency and duration, whereas the pain resulting from injections with hypotonic saline was reported to be localized, sharp, and of short latency and duration (Wolff & Jarvik, 1963). Although normal muscle is not particularly sensitive to needle insertion alone (Travell, 1955), or injection with isotonic solutions such as morphine sulfate or meperidine hydrochloride, it is noted that repeated and frequent injections, with a solution such as meperidine hydrochloride, into any one muscle can result in irritation and fibrosis of the muscle tissue (Goodman & Gilman, 1980).

Duration of Injection of Fluid

Pain from intramuscular injection may also arise from mechanical trauma to the muscle, which may occur from either the needle insertion or the distention of the tissue from the rapid introduction of the solution (Travell, 1955). Sensory innervation of muscle is thought to consist predominantly of pressure-sensitive nerve fibers (Travell, 1955; Zelman, 1961). Therefore, slow injection of the solution allows for the distention of an accommodating space within the muscle, thus decreasing the pain sensations of the pressure-sensitive nerves within the muscle (Zelman, 1961). Injections lasting over 20 seconds result in a lower intensity of pain during injection and shorter duration of pain after injection than injections lasting less than 20 seconds (Perez, 1984).

Positioning of the Patient for an Intramuscular Injection

Pain from intramuscular injection may also result if the injection is given into a contracted muscle (Kruszewski, et al., 1979; Rettig & Southby, 1982; Zelman, 1961). To administer an intramuscular injection at the dorsogluteal site, the patient should be placed prone with toes pointed inward. This position causes internal rotation of the femur and relaxation of the gluteal muscle, which results in increased accommodation of the injected solution and decreased pain (Zelman, 1961). Intramuscular injections in the dorsogluteal site with the patient in the prone position, femurs internally rotated, and toes pointed inward, resulted in lower intensity of pain than intramuscular injections with femurs externally rotated and toes pointed outward (Kruszewski, et al.,

1979). There was no significant difference in discomfort of dorsogluteal injections for the prone position compared to the side-lying position (Rettig & Southby, 1982).

Anatomy of the Gluteal Region

Although intramuscular injections can be given at sites in the upper arm and the thigh, the sites of the gluteal region are most often used in practice. The gluteal region is the area which is bounded by the iliac crest, the anterior superior iliac spine, inferior gluteal fold and the division between the buttocks. The three muscles involved when administering intramuscular injections using either the dorsogluteal or ventrogluteal sites are the gluteus maximus, gluteus medius, and gluteus minimus (Twietmeyer & McCracken, 1988). These muscles form a muscular mass important to maintaining posture and producing movement of the hip and thigh. The muscle mass is covered by thick superficial fascia and extensive fat deposits ranging in thickness, from 9.0 cm. in very obese individuals to 1.0 cm. in old and emaciated people (Lachman, 1963; Moffat & Mottram, 1987; Pitel & Wemett, 1964). Hence, it can be difficult to estimate the depth of the musculature. A miscalculation can result in the fluid being injected into the subcutaneous tissue, which may alter drug absorption and cause pain (Lachman,1963).

The Dorsogluteal Site

The dorsogluteal site for intramuscular injection utilizes the gluteus maximus muscle which is the most superficial muscle of the gluteal region. It arises from the lateral surface of the ilium, and the adjoining

portion of the dorsal surface of the sacrum and coccyx, and the sacrotuberous ligament. The gluteus maximus muscle fibers pass laterally downward inserting into the iliotibial tract and the posterior or gluteal tuberosity of the femur (Moffat & Mottram, 1987; Silverstein, 1983). The gluteus maximus muscle occupies all quadrants of the buttock, except for a small area in the outer angle of the upper outer quadrant where the gluteus medius and gluteus minimus are located. The buttock is the region bounded superiorly by the crest of the ilium, inferiorly by the gluteal fold, medially by the sacrum and coccyx, and laterally by the lateral border of the thigh and hip when viewed posteriorly (Pitel & Wemett, 1964).

The gluteus maximus muscle is supplied with blood via branches of the superior gluteal artery. The superior gluteal artery leaves the pelvis through the greater sciatic foramen and divides into deep and superficial branches, with the superficial branch supplying the gluteus maximus muscle (Silverstein, 1983). The inferior gluteal nerve, which is the only motor supply to the gluteus maximus muscle, accompanies the branches of the artery and enters the gluteus maximus muscle near its center. The sciatic nerve lies under the gluteus maximus muscle, arising just below the piriformis muscle and travels down between the greater trochanter of the femur and the ischial tuberosity, entering the thigh at the lower border of the gluteus maximus muscle (Lachman, 1963; Pitel & Wemett, 1964; Silverstein, 1983).

The Ventrogluteal Site

The ventrogluteal site for intramuscular injection utilizes the gluteus medius and gluteus minimus muscles. The gluteus medius muscle is strong and thick as it arises, in part, from the the deep fascia covering of the gluteus maximus muscle, as well as from the lateral surface of the middle portion of the ilium. The gluteus medius muscle inserts into the greater trochanter of the femur. The gluteus minimus muscle, which lies beneath the gluteus medius, also arises from the lateral surface of the middle portion of the ilium and inserts into the anterior surface of the greater trochanter of the femur (Silverstein, 1983).

The blood supply to the gluteus medius and gluteus minimus muscles is through the deep branches of the superior gluteal artery which divide into a superior and inferior ramus. The superior ramus anastomoses with the arteries of the region, and the inferior ramus supplies the gluteus medius and minimus muscles (Silverstein, 1983). The superior gluteal vessels and nerves travel between the gluteus medius and minimus muscles, forming a fan-shape.

Choice of Site for Intramuscular Injection: Dorsogluteal or Ventrogluteal

The dorsogluteal site, utilizing the gluteus maximus muscle, is often referred to as the time honored site for intramuscular injection. The muscle mass is large and there is little probability of hitting bone (Pitel & Wemett, 1964; Shallowhorn, 1954). Another reason for the long standing selection of the dorsogluteal site using the gluteus maximus muscle may be related to 'trigger' areas (Travell, 1955). 'Trigger' areas are

hypersensitive areas within muscle that when stimulated by direct pressure set off referred pain or pain at a distance. These areas are less likely to develop in the gluteus maximus and gluteus medius muscles than in the gluteus minimus muscle (Travell, 1955).

Others note that the choice of site is dependent on the type of drug, the needle size, the dosage, and the patient's condition (Geolot & McKinney, 1975; McConnell, 1982; Shepherd & Swearington, 1984). The ventrogluteal site is noted to be free of major nerves and blood vessels, can be easily landmarked by palpation of available bony markings, and thus may be preferred for deep intramuscular and z-track injection (Jerrett, 1983; McConnell, 1982; Zelman, 1961). Some clinical reports suggest that intramuscular injection at the ventrogluteal site may produce less pain (Feldman, 1987; Zelman, 1961). The ventrogluteal site is also preferred in the elderly, nonambulatory and emaciated patients, as this muscle mass is less likely to degenerate (McConnell, 1982).

One researcher attempted to determine if there was a relationship between patients being able to choose the site where their intramuscular injections were to be given and the degree of pain perceived following the injection (Levin, 1982). No difference in pain was found when patients were allowed to choose the site for their injection compared to patients who were not given a choice (Levin, 1982).

Pain

Pain is a complex phenomenon that is not easily or completely understood, nor easily defined in terms of quality or quantity (Cazzullo & Gala, 1987). Definitions of pain are often broad, such as 'pain' is whatever the person experiencing it says it is, existing whenever the person says it does (Orshan, 1988). Pain is often referred to as a personal experience that can never be fully assessed by an observer (Sternbach, 1968; Stewart, 1977).

According to the Gate Control Theory, (Melzack & Wall, 1965) pain is transmitted via nonmyelinated small-diameter neural fibers to the substantia gelatinosa, which is located in the dorsal root of the spinal cord. The substantia gelatinosa acts as a gateway between the stimuli and the brain and is capable of stopping transmission to the brain. If large-diameter, myelinated fibers are active, they close the gate, preventing the small fibers from sending pain impulses to the brain (Orshan, 1988).

The brain is also able to close the gate by initiating a descending blocking action on the gating mechanism. The brainstem seems to activate descending influences whenever pain is encountered. The descending influences form a feedback loop within the dorsal root, substantia gelatinosa of the spinal cord which prevent additional pain impulses from ascending to the cerebral cortex for perception. However, if the pain is strong, the pain stimuli can reopen the gate and the sensation of pain will be perceived in the brain (Dolphin, 1965; Orshan,

1988). The cerebral cortex also has a descending influence, which may be either excitatory or inhibitory, on pain impulses that reach the brain. An example of excitatory descending influence is the increase in pain perceived by the individual after they look at a wound and become anxious or fearful, whereas mental imagery of the healing processes, accompanied by relaxation, is an example of cerebral cortex activity that may reduce pain perception (Dolphin, 1965; Orshan, 1988).

Measurement of Pain

Assessment of the complex phenomenon of pain is difficult as the pain experience is private to the individual and no direct measures exist. Pain intensity is indirectly measured or subjectively quantified through the use of psychometric scales (Chapman, Dubner, Foley, Gracely, & Reading, 1985; Kremer, Atkinson, & Ignelzi, 1981; Woodforde & Merskey, 1971). It is the individual's subjective report that is the most reliable measurement of pain (Huskisson, 1974; Woodforde & Merskey, 1971). Subjective pain intensity can be reported on a variety of pain intensity scales. The visual analogue scale (VAS) and descriptive scales, that include both numerical and or verbal adjectives, will be discussed.

The VAS was originally developed to measure "well-being" (Clark & Spear, 1964). The scale was then adapted to measure pain intensity (Pilowsky & Kaufman, 1965; Pilowsky & Bond, 1969). The scale consists of two descriptors on either end of a ten centimeter line: "No pain at all" at the left end and " As painful as it could possibly be" at the right end. The individual rates pain by making a mark through the line with a pencil. A

"pain score" is obtained by measuring the number of centimeters from the left end of the line to the pencil mark.

The VAS is considered to be a reliable and valid paper and pencil instrument for measuring pain intensity (Huskisson, 1974; Kremer, et al., 1981). Some advantages of the VAS are: pain estimates are reliable over time (Huskisson, 1974; Revill, Robinson, Rosen, & Hogg, 1976), variance resulting from psychomotor factors is small (Revill, et al., 1976), distribution of pain intensity estimates are uniform (Huskisson, 1974), and the individual is not confined to evaluating their pain with numerical or word descriptors (Levin, 1982).

The major disadvantage of the VAS is that some individuals cannot understand how to report their pain on the scale. Although there is no precise data defining the reason for this difficulty, it is postulated that it is related to deficits in abstract thinking (Kremer, et al., 1981). Findings from one study indicated that older individuals, whose abstract ability may have deteriorated, were the group who failed significantly when compared to individuals who succeeded in using the VAS (Kremer, et.al.,1981). Hence, use of the VAS may not be recommended in populations of elderly individuals.

Descriptive scales may consist of numbers, adjectives, or both. Advantages of descriptive scales are that they are easier for individuals to use (Huskisson, 1974; Stewart, 1977) and are preferred by some patients (Kremer, et al., 1981). A disadvantage of descriptive scales is their lack of sensitivity, as the subject must correlate their pain to the

corresponding word, number, or word and number combination. This can be problematic as the words may not necessarily mean the same thing to all the subjects (Ohnhaus & Adler, 1975). Also a subject who reports that pain is mild can only improve by choosing no pain, which may not be the case (Huskisson, 1974). Another disadvantage is that it must be assumed that, when attaching scores to the adjectives, that the distance between them is equal (Huskisson, 1974). Numerical scales such as 0 - 100 are often preferred for statistical purposes as they are more sensitive to change and provide a greater range of scores over the adjective and adjective-number combination (Kremer, et al., 1981).

Summary

As determined by this review of the literature, it can be said that: (1) intramuscular injection requires aseptic sterile technique, (2) there is a need for aspiration prior to injection of medication, (3) the medication should be injected slowly, (4) the gluteal muscles should be relaxed, and (5) the z-track method may prevent leakage of fluid into the subcutaneous tissue, thereby reducing pain.

On the other hand, the literature does not provide information about: (1) which technique (z-track or standard) is preferable for each of the sites, (2) whether or not an air bubble should be in the syringe, and (3) which site (dorsogluteal or ventrogluteal) is better for intramuscular injection.

Conclusion

In conclusion, nurses administer intramuscular injections to relieve pain and symptoms or to prevent illness. Both nurses and patients may feel anxious about intramuscular injections as injections are often quite painful (Field, 1981). The therapeutic procedure of intramuscular injection to administer medication is a long standing nursing responsibility for which considerable clinical knowledge has been accrued. However, little research has been done to assess clinical views about one of the most common techniques performed by nurses. Further a review of the literature suggests that little is known about some aspects of administering intramuscular injections. Technically well given injections may be an important way of decreasing the associated pain and anxiety. Therefore research comparing the technical aspects of intramuscular injection and the resultant pain will be of benefit to nursing practice.

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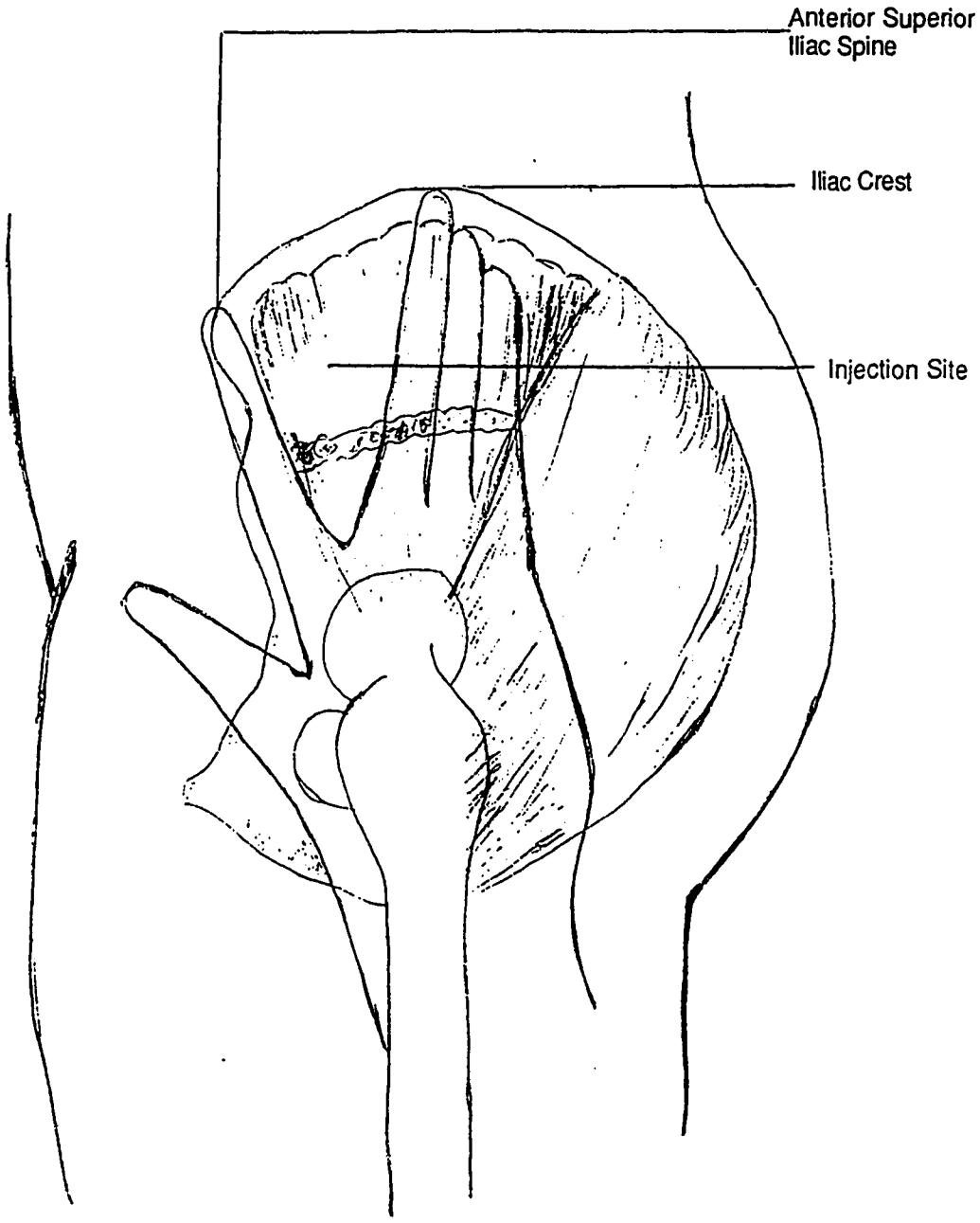
Appendix B

Visual Analog Scale for Pain

NO PAIN_____AS PAINFUL AS IT COULD BE

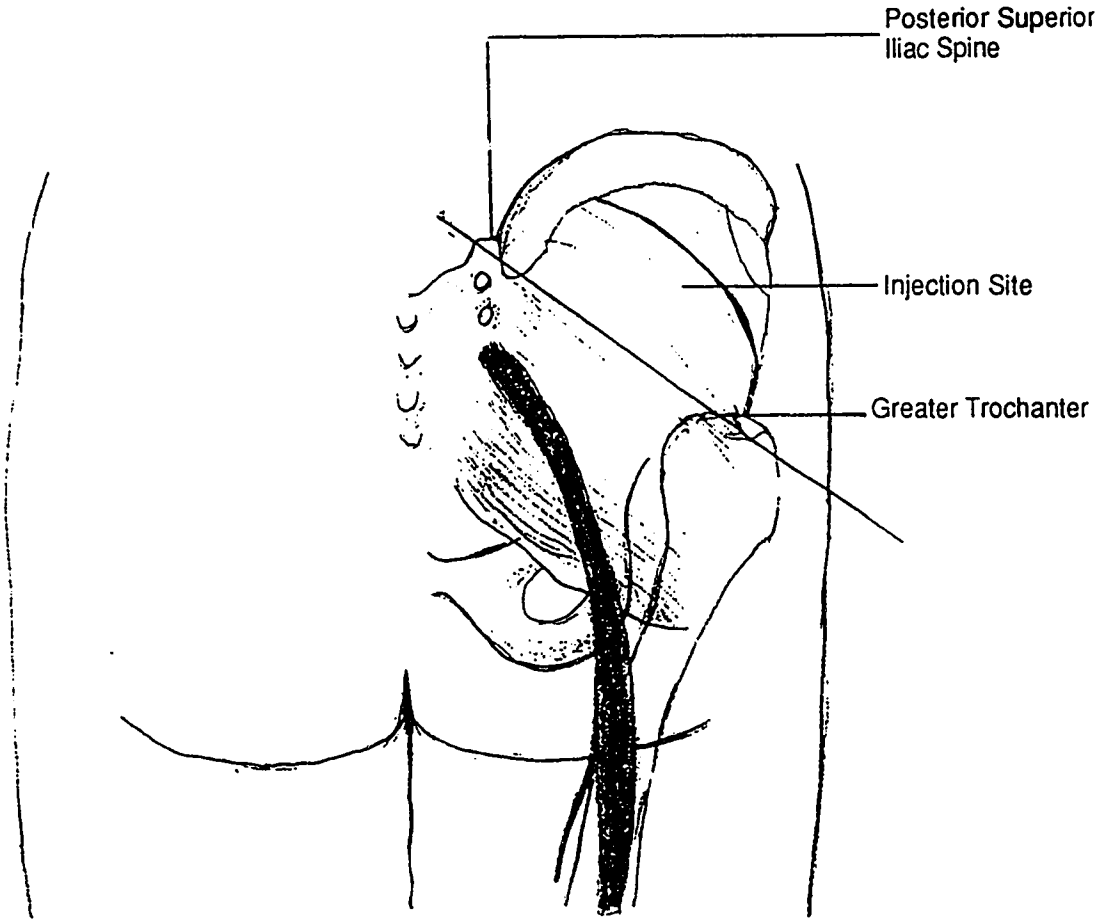
Appendix C

Diagram of The Ventrogluteal Site



Appendix D

Diagram of The Dorsogluteal Site



Appendix E

Design of The Study