

REVISIONES

Intramuscular vaccines: good administration practice

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SUMMARY

Based on international recommendations and the scientific literature, the recommended injection sites for the intramuscular administration of vaccines in new-borns, infants and children under one year are the upper antero-lateral side of the thigh (*vastus lateralis* *M. quadriceps*) or the upper arm (*M. deltoideus*). For those older than one year it is the upper arm.

The choice of these sites guarantees both the intramuscular absorption of the injected antigen and thereby maximum efficacy of the vaccine and maximum vaccination safety.

With vaccination in the upper outer quadrant of the buttock there is a good chance that the vaccine will be injected into subcutaneous tissue, resulting in lowered immunogenicity.

The injection needles for intramuscular administration of vaccines must be long enough to penetrate the muscle adequately (16-25 mm).

There are two vaccination techniques: one where the muscle mass at the injection site is pushed together, and another where the skin is stretched between the thumb and first finger. A specific length of needle should be used, depending on the vaccination technique: 25 mm needles for the first technique and 16 mm for the second.

KEY WORDS: Injection site. Vaccine. Intramuscular. Vaccination technique.

Introduction

Vaccines must be administered at a site that guarantees optimal absorption of the injected antigen and also where there is little likelihood of local, neural, vascular or tissue damage¹.

The information contained in the information leaflet written by the vaccine producers and approved by the Ministry of Public

Health is usually clear with regard to the route of administration (intramuscular or subcutaneous), but allows a certain flexibility as regards the choice of injection site. The majority of vaccines are given via the intramuscular route.

The objective of this paper is to review the importance of the correct injection site and vaccination technique for the intramuscular administration of vaccines.

The injection site

Taking the arguments regarding adequate immune response and safety into account, the recommended injection sites for the intramuscular administration of vaccines to new-borns, infants and children under one year are the upper antero-lateral section of the thigh (*vastus lateralis* *M. quadriceps*) or the upper arm (*M. deltoideus*). For children over one year and for older children, adolescents and adults, the recommended injection site for the intramuscular administration of a vaccine is the upper arm (*M. deltoideus*) (fig. 1)^{1,2}.

The choice of these sites optimises the immunogenicity of the vaccine and reduces the probability of adverse reactions at the injection site¹. In addition the volume injected and the size of the muscle also play a role. In children under one year the thigh muscle is the most developed. In older children the *M. deltoideus* is large enough for intramuscular vaccinations¹. This is also the site of choice in adults².

A vaccination at the level of the *M. deltoideus* means that the person to be vaccinated bares the upper arm completely and that the needle penetrates perpendicularly into the muscle halfway between the acromion and the caudal junction of the *M. deltoideus* (fig. 1).

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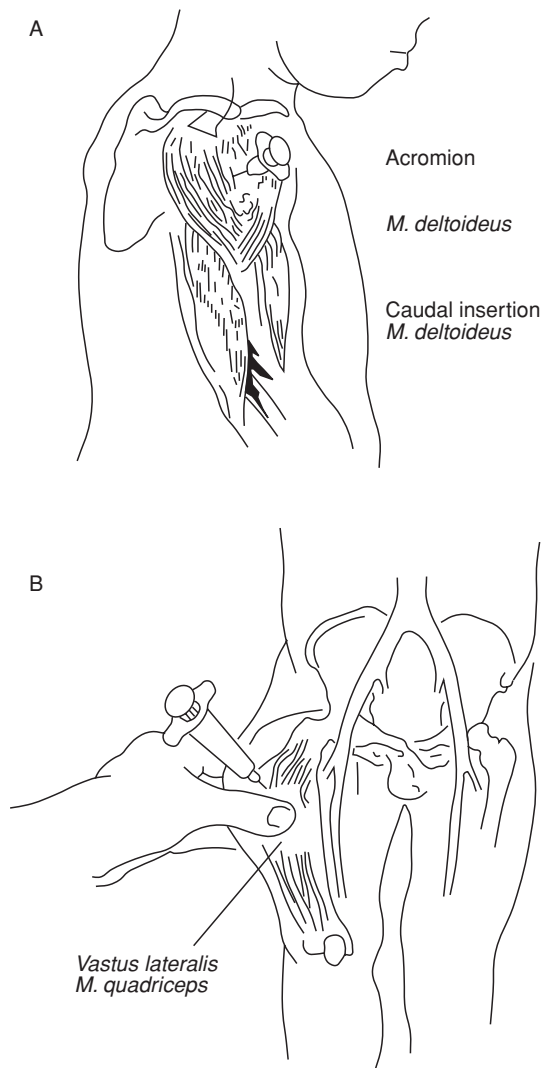


Fig. 1. Intramuscular injection site for vaccines, A: Injection in the deltoid muscle. B: Injection in the anterolateral thigh.

The upper outer quadrant of the buttock (*M. gluteus*) is not recommended as an injection site for vaccines: in infants the gluteal region is, in fact, made up mainly of fatty tissue. In addition there is the danger of damaging the N. ischiadicus. In adults the wide differences in thickness of subcutaneous fat layer also have to be taken into account. Irrespective of body weight, the average gluteal subcutaneous fat layer in women is 25 mm thicker than in men³. For this reason most injections into the buttocks in adults end up in fatty tissue instead of in muscle, resulting in reduced immunogenicity (see below)⁴. With a 35 mm needle, an «intramuscular» injection in the buttocks goes into fatty tissue in more than 95% of women and more than 85% of men³.

For this reason use of the buttock area is not recommended for the administration of vaccines, but only for the administration of immunoglobulins, antibiotics or vitamins, in which case care should be taken to aim the injection needle perpendicular to the longitudinal axis of the patient¹.

The ventrogluteal region (the centre of the triangle formed by the spina iliaca anterior superior, the tuberculum of the hip crest and the upper border of the trochanter major) is free of important

nerves and blood vessels. Clinical information regarding the use of this site is rather sparse^{1,5}.

The use of multiple injection sites is preferable for the administration of multiple vaccines at the same time, for example in the case of travel vaccinations. The absorption of the injected material is thereby enhanced and adverse effects will be less frequent. If several injections are given into the same site, special attention should be given to the early diagnosis and treatment of potential muscle contracture⁵, which occurs more with the administration of antibiotics or vitamins than with vaccines.

The influence of the injection site on the immune response

The choice of injection site can have an effect on the immunogenicity of the injected vaccine. This has been repeatedly observed in the case of the hepatitis B vaccine: the titre of induced antibodies was significantly lower in subjects vaccinated in the buttock area when compared to those given the vaccine in the upper arm (*M. deltoideus*)^{1,2,4,6,7}. The difference could be explained by most of the gluteal injections going into fatty tissue instead of into muscle^{3,7}. It is of vital importance for the efficacy of a vaccine that the inoculant be given intramuscularly.

The effect of the vaccination site on immune response was similarly demonstrated by the rabies vaccine^{1,8}.

On this evidence, it is suggested that the administration of vaccines into the upper arm (*M. deltoideus*) or the antero-lateral side of the thigh (*vastus lateralis M. quadriceps*) of children under the age of one year offers the best guarantee of a successful immune response and should thus be considered as the method of choice.

In addition, as vaccines studied in clinical trials are administered in the anterolateral part of the *M. quadriceps* or in the upper arm, clinical trial data cannot be extrapolated if the vaccines are administered differently.

Volume

The maximum volume for intramuscular injections into one site is 1.0 ml for infants and children under two years. For new-borns and infants with a low muscle mass, 0.5 ml is recommended as the upper limit^{2,9}.

Injection technique and needle length

The injection technique determines how deeply a substance is injected. Two injection techniques for vaccinations are recommended.

In the first, commonly used in the United States, the muscle mass at the injection site is compressed to ensure better muscle penetration and the needle must enter at a 45° inferior posterior angle.

The second, recommended by the World Health Organisation (WHO), involves stretching the skin between the thumb and forefinger. The needle is inserted at a 90° angle to the skin, almost up to the hub¹⁰.

For both techniques, immediately after introduction of the needle, the syringe plunger has to be pulled back slightly to make sure that the needle has not entered a vein. If blood appears in the needle hub, the needle should be removed and injection should be repeated at a new site.

With respect to needle length, the use of a 22 mm (7/8 inch) needle, or longer, is recommended both by the WHO and the Committee on Infectious Diseases of the American Academy of Pediatrics¹.

Needles for intramuscular injections must be long enough for good penetration of the muscle. As a rule, a needle of 22 mm or longer is needed to guarantee good muscle penetration in a 4 month old baby¹. For adults, a minimum length of 25 mm is recommended². According to the study by Poland et al, specific needle lengths are required for intramuscular vaccinations into the *M. deltoideus* to guarantee a muscle penetration of at least 5 mm (table 1)¹¹.

However, some vaccines are supplied with a 16 mm long needle. The suitability of these shorter needles has been questioned^{1,10,12}. They may be effective for intramuscular vaccinations but only for a specific injection technique (fig. 2). The ultrasonographic measurement of subcutaneous tissue and of the fat and muscle mass of the thigh (*M. quadriceps*) and the upper arm (*M. deltoideus*) performed by Groswasser et al. showed that the vaccination technique recommended by the WHO can be carried out perfectly with a 16 mm needle¹⁰. With the use of a 25 mm needle in this injection technique there could be a risk of damage to the neurovascular structure or bone. In contrast, the 25 mm needles are suitable for the technique used widely in the United States. Vaccination with a 16 mm needle following the American injection method carries a risk of subcutaneous administration¹⁰. The injection technique and the needle length, taken together, are one of the most important factors in guaranteeing efficient intramuscular vaccination: the choice of injection technique determines the most suitable needle length (fig. 2).

Recent data in a small group of infants (n = 110) suggest, however, that the use of a 23 gauge 25 mm needle (versus a 25 gauge

TABLE 1
Required needle length for intramuscular administration related to gender¹¹

Gender	Body weight	Needle length
Men	Irrespective	25 mm (1 inch)
Women	< 60 kg	16 mm (5/8 inch)
	60-90 kg	25 mm (1 inch)
	> 90 kg	38 mm (1.5 inch)

16 mm needle) with the WHO technique would significantly reduce the rate of local reactions (redness and swelling)¹². Further research is needed to clarify which of these factors (needle length, needle bore (23 versus 25 gauge)) determined the observed differences in the rates of redness and swelling. It may be supposed that 25 gauge needles cause more local trauma because they have a narrower bore and not necessarily because they are shorter. A 23 gauge needle produces a jet under lower pressure in the tissue, which causes less local damage^{12,13}.

Complications and contraindications

The optimisation of all the determinants, such as injection route, site, technique and needle length will not prevent all potential side effects¹⁰. Serious side effects caused solely by the insertion of the injection needle are extremely rare. Reported events are: broken needles, muscle contractures, nerve damage, bacterial and sterile abscesses, skin pigmentation, bleeding, cellulitis, tissue necrosis, gangrene, local atrophy, periostitis, cyst or scar formation and accidental injection into a space. Sterile and bacterial abscesses at the injection site occur with a frequency of approximately 1 per 100,000 to 166,000 doses DTP¹. The incidence of the other complications is not known¹. While serious reactions to intramuscular

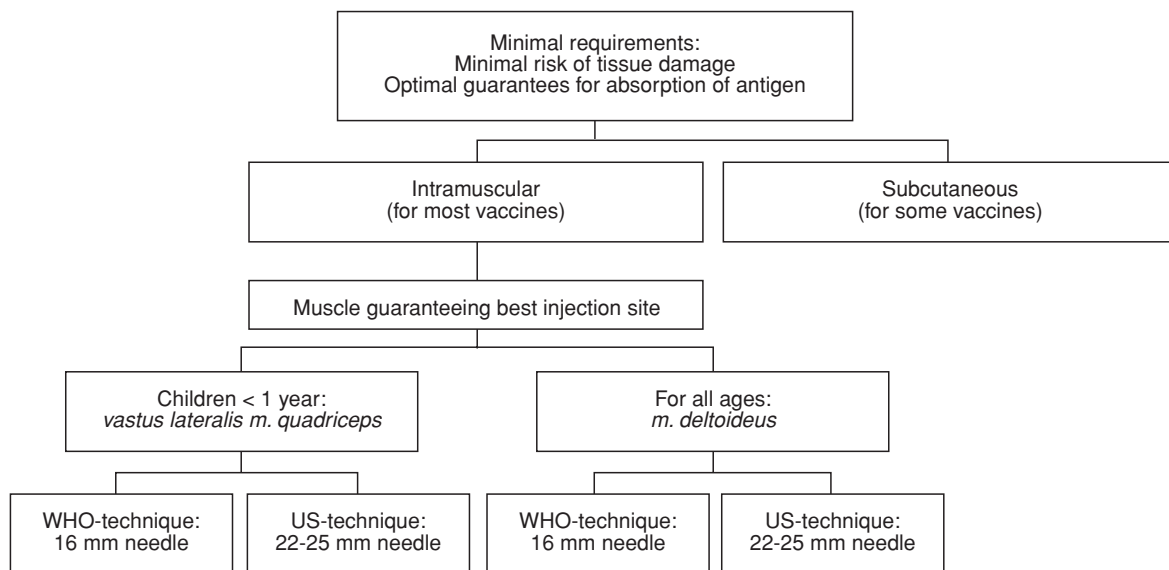


Fig. 2. Administration of vaccine.

injections are rare, subcutaneous injections can cause abscesses and granulomas. As fatty tissue has a less abundant blood supply and worse drainage compared to muscle tissue, it retains injected substances for a longer time and is more susceptible to adverse effects^{11,13,14}.

It should be emphasized that intramuscular administration of vaccines is absolutely contraindicated in patients with coagulation disorders, because of the risk of bleeding. In this specific situation intramuscular vaccines must be given subcutaneously¹⁵.

Conclusions

The administration of a vaccine into the buttock area gives an insufficient guarantee of adequate absorption of the injected antigen. A number of studies have highlighted the importance of administering vaccines correctly, i.e. in the deltoid or the antero-lateral aspect of the thigh for intramuscular administration. Too often, influenza, hepatitis B and tetanus vaccines (to name but a few) are still given in the buttock area, for the simple reason that the vaccine recipient tolerates it well.

The importance of immunogenicity should not be overlooked. How many cases of non response to influenza or hepatitis B vaccine could be a result of a vaccination into the buttock instead of the arm? What counts is the immunological response of the vaccinee to the injected antigen, as well as the safety of the vaccine. The *M. deltoideus* and the antero-lateral side of the thigh (*vastus lateralis* of the *M. quadriceps*) offer sufficient guarantees for safe, intramuscular and effective vaccination.

In addition, depending upon the individual injection technique adopted there will be a particular choice of needle length. Conversely, a suitable injection technique must be used in relation to the needles supplied with the vaccines. In terms of local reactions, further research is needed to examine the additional role played by the needle gauge.

These simple skills are also part of 'good clinical practice' and their teaching has a place in the practical education of the medical and para-medical curriculum as well as in postgraduate education.

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