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Çocuklarda İntramusküler Enjeksiyon Uygulamalarında Ventrogluteal Bölgenin Tercih Edilmesi: Sistematik Derleme

Preference Of the Ventrogluteal Region in Intramuscular Injection in Children: Systematic Review

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Öz

Amaç: İlaç uygulaması özellikle çocuklarda, hemşirelerin kanıta dayalı uygulamaları takip etmesini gerektiren önemli bir uygulamadır. Hemşireler, intramüsküler (IM) enjeksiyon yoluyla ilaç uygularken, çocuğun yaşı, kilosu, enjeksiyon bölgesinin ana sinirlere ve kan damarlarına uzaklığı, kas kütlesi ve enjeksiyon bölgesinin kolay tanımlanması gibi çeşitli faktörleri göz önünde bulundurmalıdır. Bu sistematik derleme, çocuklarda ventrogluteal (VG) bölgenin güvenliğini değerlendirmeyi amaçlamaktadır.

Gereç ve Yöntem: Bu sistematik derleme, Ocak 2000 ile Temmuz 2021 tarihleri arasında İngilizce dilinde yapılan araştırmaları içermektedir. Pubmed, Google Scholar, Science Direct ve Wiley veri tabanlarında 'ventrogluteal, intramusküler' anahtar kelimeleri kullanılarak kapsamlı bir arama yapıldı ve 963 çalışma belirlendi. Dahil etme kriterlerimize göre bu sistematik inceleme için 13 çalışma seçildi.

Bulgular: Bu derlemede kriterleri karşılayan 13 çalışmanın sonuçları aşı, kas kalınlığı ve IM enjeksiyon komplikasyonları olarak üç ana başlık altında gruplandırıldı. Aşı başlığı altındaki çalışmalarda (n=4) aşının immünolojik yanıtı, VG bölgesi yoluyla uygulanan aşının ebeveyn tarafından kabul edilebilirliği ve aşıların yan etkilerine odaklanmıştır. Kas kalınlığı başlığı altındaki çalışmalar (n=4) kas tabakasının kalınlığına odaklanmıştır. IM enjeksiyon komplikasyonları başlığı altındaki çalışmalar (n=5) siyatik sinir yaralanmaları ile lokal ve sistemik yan etkilere odaklanmıştır.

Sonuç: Ventrogluteal alan IM enjeksiyon için tüm yaş gruplarında iatrojenik sinir hasarı ve lokal ve sistemik yan etkiler açısından daha az risklidir. Ancak bu çalışmaların sonuçları doğrultusunda VG'nin IM enjeksiyonda güvenli kullanımını belirlemek için daha fazla çalışmaya ihtiyaç vardır.

Anahtar Kelimeler: Ventrogluteal, intramüsküler, hemşire

Abstract

Aim: Drug administration, particularly in children, is a crucial practice of nurses that requires follow up to evidence-based practices. When administering drugs via intramuscular (IM) injection, nurses need to consider several factors, including the child's age, weight, distance of the injection site from major nerves and blood vessels, muscle mass, and ease of identification of the injection site. This systematic review aims to evaluate the safety of the ventrogluteal (VG) region in children.

Material and Methods: This systematic review includes research conducted in the English language between January 2000 and July 2021. A comprehensive search using the keywords 'ventrogluteal, intramuscular' was conducted on Pubmed, Google Scholar, Science Direct, and Wiley databases, resulting in the identification of 963 studies. Thirteen studies were selected for this systematic review based on our inclusion criteria.

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Results: In this review, outcomes of the 13 studies that met the criteria, were grouped under three main headings as vaccine, muscle thickness and complications of IM injection. The studies (n=4) under the headings of vaccine focused on immunological response of vaccine, parental acceptability of the vaccine administered via VG region, and side effects of vaccines. The studies (n=4) under the headings of muscle thickness focused on thickness of the muscle layer. The studies (n=5) under the headings of complications of IM injection focused on sciatic nerve injuries and local and systemic side effects.

Conclusion: The ventrogluteal area for IM is less risky in terms of iatrogenic nerve injury and local and systemic side effects in all age groups. However, in line with the results of these studies, more studies are needed to determine safety use of VG for IM injection.

Keywords: Ventrogluteal, intramuscular, nurse

Introduction

Ensuring patient safety and preventing medical errors are top priorities for healthcare institutions. Nurses, who have the closest contact with patients, their relatives, and other healthcare providers, need to adhere to the ethical principle of 'do no harm' while fulfilling their roles (1). One crucial aspect of pediatric nursing is parenteral drug administration. In drug administration, the pediatric nurses need to have competence on preparation of drugs, understanding of drug interactions, choosing the appropriate route, and monitoring side effects of drugs in children (2). Due to the physiological and anatomical features of children, they are more sensitive to medication errors (3,4). Thus, the nurses should to adhere to the principle of superior benefit and be aware of the physiological and pharmacokinetic differences between adults and children (2).

One of the route for injections is intramuscular (IM) injections. Intramuscular injections are a crucial and controversial area of drug administration, particularly in vaccine applications for children (5). Dorsogluteal (DG) region, deltoid muscle, Ventrogluteal (VG) region, vastus lateralis (VL), and deltoid muscles are often performed for IM injection in children. Although the IM route has several advantages, such as faster drug absorption due to the rich vascular bed and providing a safe area for drugs that may be risky to administer intensively or by other routes due to muscle density, there are also some risks associated with its proximity to main blood vessels and nerve networks depending on the region of application (5). Sciatic neuropathy is the second most common neuropathy of the lower extremity after peroneal neuropathy and has been frequently reported in children, especially after IM injection administered into the DG region (6,7).

The American Academy of Pediatrics (APA) recommends that IM should be administered primarily through the vastus lateralis muscle in children under three years of age,

and if muscle mass is sufficient, the deltoid muscle can also be used in children aged 1-2 years. In older children, the APA recommends that IM vaccine injection should be performed in the deltoid muscle and the vastus lateralis should be used as an alternative site (8). When deciding on the injection site, the nurse should consider several factors, including the child's age and weight, the distance of the injection site from the major blood vessels and nerves, muscle mass, and the volume of the drug (9).

Ventrogluteal site rather than the DG site is recommended for IM injection as it has no nerves or large blood vessels and is the safest injection site both adults and children over the age of 7 months. According to Von Hochstetter et al. (1950) the VG region located within the triangle of the anterior superior iliac spine (from the front), major trochanter (down), and iliac crest (top) has been defined as a 'safe' area for gluteal injection (10) . Recent literature also supports the safety of the VG region for IM injections in children (5,9,11,12). This systematic review aims to assess the safety of the VG region in children. In this way the data obtained as a result of this systematic review will guide nursing practices.

Material and Methods

Study Selection

We reviewed all quantitative studies that addressed the assess the safety of the VG region in children.

Inclusion Criteria: The studies which are research study including randomized controlled trials studies, prospective descriptive studies, retrospective descriptive studies, cadaveric studies, case reports., include pediatric sample, search the safety of VG region and conduct in the English language were included to the scope of the review.

Exclusion Criteria: The reviews, master's and doctoral thesis, congress proceedings, book chapters, studies were excluded.

Screening the Literature

A comprehensive search was conducted using the keywords "ventrogluteal", "intramuscular" on four electronic databases: PubMed, Google Scholar, ScienceDirect, and Wiley. The search took place from January 2000 to July 2021.

Study selection

Thirteen studies were included using the PRISMA Statement (Figure 1). For study selection; the researchers first searched the database to identify and select studies. Scanned studies were created with the Mendeley Reference Management Tool. In the first stage, outlines and abstracts of articles were selected according to inclusion and exclusion criteria. Selected works examined in full text. Those who were asked to be excluded from the research; The study

extraction process was carried out independently by the primary (GS) and secondary researchers (DS). If there was a difference of opinion between the two researchers, a third researcher 's (DY) opinion was consulted, an expert on the subject.

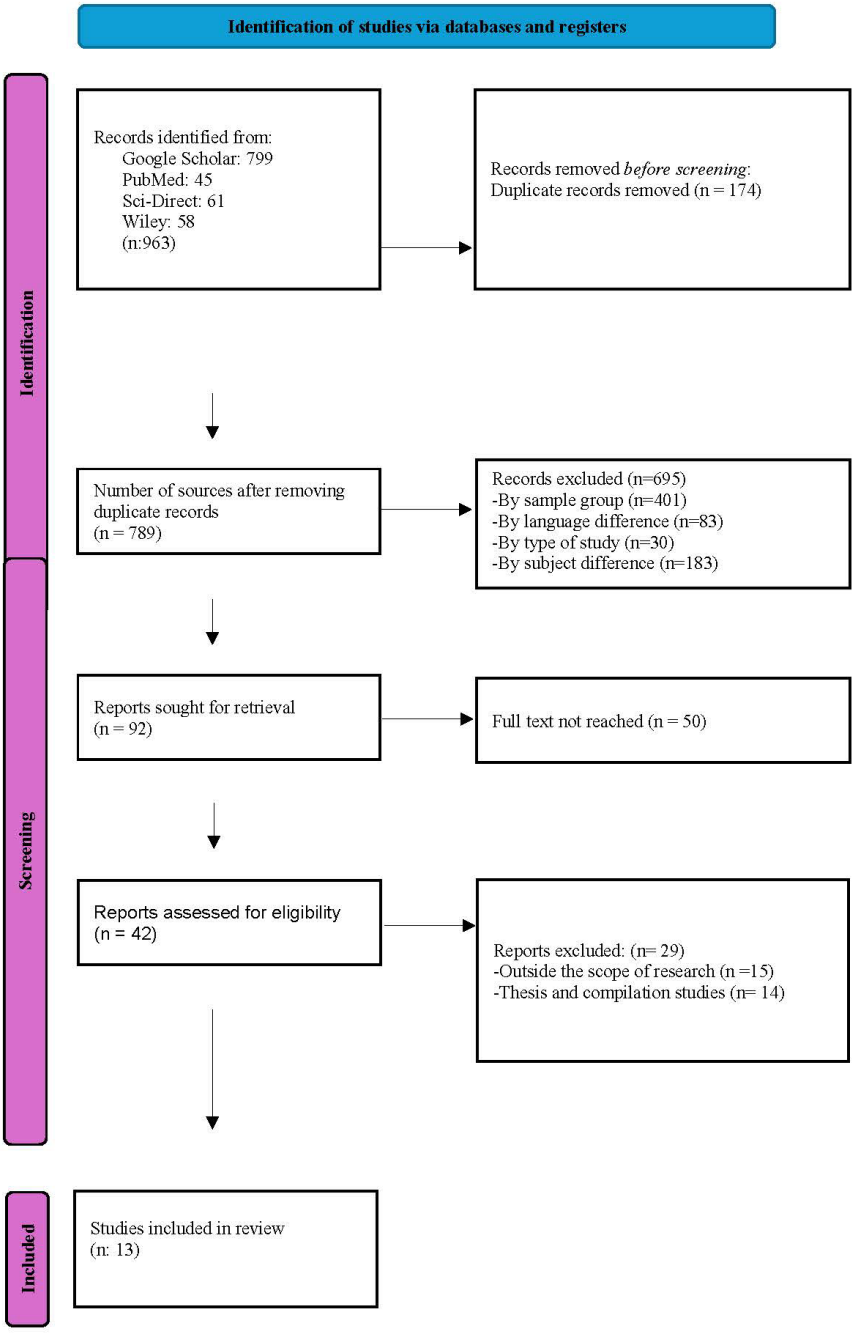

Figure 1. PRISMA statetement of the study

Results

The review included a sample group of 4129 children across 13 studies. Of these studies, four were randomized controlled trials, four were prospective descriptive studies, one was a retrospective descriptive study, one was a cadaveric study, and three were case reports. The systematic review analyzed various vaccine studies. One group compared immunity and side effects of vaccines administered to the VG region and vastus lateralis. Another group included measurements of subcutaneous tissue thickness and muscle thickness, as well as comparisons of injection sites in the deltoid, vastus lateralis and VG regions. Additionally, case reports were included that described complications after IM injections from DG and vastus lateralis regions. The data from the examined articles were categorized under the headings 'Authors', 'Type of Study', 'Findings', and 'Suggestions' (Table 1).

Table 1. Summary of Selected Studies (VG: ventrogluteal, VL: vastus lateralis, AL: anterolateral, DG: dorsogluteal)

STUDY	TYPE	RESULTS	RECOMMENDATION
Cook et al., (2002)	Randomized controlled trial (n=177, <10 mo)	No difference between VG and VL in Hepatitis B immunity	VG site may be preferred for Hepatitis B vaccination
Cook et al., (2003)	Randomized trial (n=566, 2-18 mo)	Adverse effects: VL>VG	Ventrogluteal region; for DTPw, DTPa and H. influenzae type b vaccine; It has been described as safe with superiority in terms of local adverse reactions and systemic reactions and high parental acceptability.
Tapianinen et al., (2005)	Randomized controlled trial (n=1510, 2-18 mo)	VG group has lower adverse reaction but not enough immunity for Bordetella pertussis	VG not recommended because of low immunity
Junqueira et al., (2010)	Randomized controlled trial (n=580, >2500 g newborns)	No difference between VG and VL in terms of immunity, fewer adverse effects in VG group	VG site is safe and eligible for newborn vaccination
Cook et al., (2006)	Descriptive study (n=642, 2-18mo)	VG site eligible for newborn vaccination	VG site is safe and eligible for newborn vaccination
Gunes et al., (2016)	Descriptive study (n=142, 1-36mo)	VG site thickness if enough for vaccination under 3 year-old infants	VG site is safe and comfortable for im injections
Atay et al., (2017)	Prospective study (n=120, <36 mo)	Thickness: Deltoid<AL<VG	Vessel and nerve injury is lower in VG group
Min et al., (2018)	Retrospective study (n=350, 0-6 y)	Computed tomography study; 1-3 years: VG thickness>DG thickness; 4-6 years: VG thickness<DG thickness	The VG and DG sites are viable options for IM injection in infants and children when the anterolateral site is difficult to access
Wu et al., (2020)	Cadaveric study (n=20, 10 adults- 10 children)	The preferred injection site is the arc-shaped, nerve-sparse zone in the superolateral quadrant.	The arc-shaped, nerve-sparse zone in the superolateral quadrant is the preferred injection site, and the superomedial quadrant near the

		Additionally, the superomedial quadrant near the lower iliac crest is also recommended as a gluteal IM injection region, as it is free from nerve injury	lower iliac crest is also recommended as a gluteal intramuscular injection region, free from nerve injury.
Alsheikh et al., (2011)	Prospective study (n=28 <5y)	Relationship between gluteal injection and sciatic nerve injury	Children are more prone to nerve injury than adults
Mueller et al., (2012)	Case report (2y)	Nikolau syndrome after 4 th dose vaccination (DTPa-IPV-HiB-HepB) on left vastus lateralis muscle.	NiS is a rare iatrogenic problem but the incidence may actually underestimated. In preterm infants it is recommended to vaccinate them in time at the same chronological age as full term infants
Aygun et al., (2019)	Case report (7y)	Nikolau syndrome after im clindamisin injection on right thigh	Safe dosage; Deltoid: 0,5-1 ml VG: 0,5-3 ml VL: 0,5-2 ml
Zhuo et al., (2019)	Case report (2y)	Drop foot after DG injection	Need guides for VG application

Studies on vaccine

A randomized controlled trial was conducted by Cook et al. (2002), to compare the immunological response of hepatitis B vaccine given by intramuscular injection into the anterolateral thigh and ventrogluteal sitein infants under 10 months of age (10). There was no significant difference between the ventrogluteal and anterolateral thigh vaccination sites with respect to hepatitis B vaccine immunogenicity (10).

The study conducted by Cook and Murtagh (2003) aimed to compare the reactogenicity and parental acceptability of the vaccine administered via intramuscular injection into the ventrogluteal and anterolateral thigh injection sites (13). In the same study it was reported that the ventrogluteal region was superior to the anterolateral region of the thigh in terms of bruising and redness/swelling (13). Whole cell pertussis vaccine (DTPw), acellular pertussis vaccine (DTPa) and the Haemophilus influenzae type b vaccine (HibTITER) and irritability, perceived fever and persistent crying and screaming but not vomiting/poor feeding and drowsiness. Moreover, level of parental acceptability for using the ventrogluteal site was high (13).

In another study, Tapiainen et al. (2005), aimed to examine the immunity and side effects of vaccines in three groups (Lederle/Takeda acellular pertussis component (DTaP) vaccine, the Lederle whole-cell component pertussis (DTwP) vaccine, diphtheria and tetanus toxoids vaccine (DT) administered to the VG and vastus lateralis regions of infants aged 2-18 months. Injection to the VG site caused fewer local and systemic reactions (14), and there were minimal differences found between the vaccines, except for the DTwP vaccine, which is not

widely used due to its inclusion of lipopolysaccharide. The study showed that the side effects of the DT vaccine administered to the VG region were remarkably high (14). In the same study, it was found that individuals exposed to pertussis in the home environment after the 4th dose of DTaB vaccine had a decrease in mean antibody value, which is important for immunity, compared to those who received the vaccine in the vastus lateralis or VG region. The researchers concluded that the vaccine was unable to provide full immunity (14).

Junqueira et al., (2010) conducted a study to compare the side effects and immune responses of HBV vaccination administered to the vastus lateralis and VG region in newborns (11). The researchers evaluated fever and local side effects two days after each vaccine dose, and immune response. No complications were reported by them after the vaccine dose in either region. However, a lower incidence of fever and local side effects was found in those administered in the VG region compared to those administered in the vastus lateralis. The researcher has indicated that the safety and efficacy of administering the HBV vaccine to infants via the VG site and this area is appropriate for IM injection (11).

Muscle thickness

Cook and Murtagh (2006), conducted a study on children to measure the dimensions of the VG area. Ultrasonography measurements revealed that the mean subcutaneous tissue layer thicknesses were similar for both the VG area and the anterolateral thigh (12). Additionally, the average thickness of the muscle layer was similar for both locations across all age groups. The study concluded that the World Health Organization (WHO) technique (25-gauge, 16 mm needle) would successfully enter the muscle at both sites in all children. Moreover, it was reported that the anxiety of child during the vaccination procedure reduced as they could be easily distracted while receiving the injection in the VG area. Consequently, the parental acceptability rate was high (12).

Yapucu Gunes et al., (2016) aimed to investigate the suitability of the VG region for IM injections in children under the three years old in their study (9). They showed that children aged between 1 and 12 months have sufficient gluteal muscles to receive IM injections. Moreover, it was reported that the muscle mass of the VG region was thicker than the anterolateral region, especially in children aged between 12 and 36 months (9). Therefore, this region was safe for IM injections in this age group due to its uncomplicated nature. Additionally, the study revealed that the thickness of both subcutaneous tissue and muscle in the deltoid region was significantly lower than in other areas. When the anterolateral site was not appropriate, the VG site has been proposed as an alternative for IM injections in children under one year of age (9). In addition, the researchers has recommended to VG site as it is a

more comfortable area to inject as it is easier to position and can be distracted more easily, reducing anxiety and fear in children and it is considered safe for administering IM injections in this age group (9).

Atay et al., (2017) in their study to evaluate the suitability of the VG region for IM injection in term babies and children under 36 months of age who are in the normal percentile and do not have pelvic, gluteal or femoral deformity; measured the subcutaneous tissue thickness of the deltoid, vastus lateralis and VG regions using ultrasound (5). As a result, it was revealed that the subcutaneous tissue in the deltoid region was thicker than the anterolateral region, and the subcutaneous tissue thickness in the anterolateral region was less than the VG region. It was concluded that injections into the VG area in children younger than 36 months are unlikely to reach the subcutaneous tissue. In addition, The researchers indicate that it is a safe area with less risk of injury since it is away from main nerves and vessels (5).

In the retrospective study conducted by Min and Kim (2018), age and body characteristics, as well as gluteal muscle thickness (MT), subcutaneous tissue thickness (SCT), and mass index (BMI) of patients aged 0-6 years, who were admitted to a tertiary hospital with various abdominal complaints and had an abdominopelvic CT scan, were analyzed (15). There was no statistically significant difference in the thickness of the muscles in the VG regions of children aged one to three years compared to those aged four to seven years. Muscles tended to be thinner at VG sites in 4 to 7-year-old, but thicker at VG sites in 1 to 3-year-old, though the differences were not significant (15).

In another study conducted by Wu et al., (2020), which suggested that the nerve-free region near the lower iliac crest in the superolateral and superomedial quadrants of the gluteus maximus and medius muscles, which constitutes approximately two-fifths of the borders of the two quadrants, has a lower risk of nerve injury when used as the site for gluteal IM injections. The VG and DG regions should be considered as alternatives for intramuscular injection in infants and children when the anterolateral region is problematic (16).

Complications of IM injection

Alsheikh (2011) reported in his study that sciatic nerve injuries were more common in children depending on their physiological age. It has been emphasized that children have a higher chance of the injection reaching the nerves than adults, due to their physiologically low gluteal subcutaneous tissue thickness and muscle mass thickness, which vary according to age groups, and their proximity to blood vessels and nerve networks, and therefore children are at greater risk in intramuscular injections. (7).

Nikolau Syndrome was diagnosed in a case reported by Mueller et al., (2012) after the fourth dose of DTPa-IPV-HiB-HepB vaccine was administered to the left vastus lateralis muscle (17). The vaccinated area exhibited a change in color and temperature on the same day, despite tolerating other vaccines well (17).

Discussion

In this systematic reviews, we identified 963 relevant citations and 13 articles met the inclusion criteria. This systematic review of quantitative studies showed that using the VG area for injections is less risky in terms of iatrogenic nerve injury and local and systemic side effects in all age groups.

Studies on vaccines

Neonatal immunization is a key global strategy to overcome morbidity and mortality due to infection early in life (18). The Centers for Disease Control and Prevention (CDC), there are only two recommended sites which are vastus lateralis muscle in the anterolateral thigh and deltoid muscle in the upper arm for administering vaccines by IM injection (19). The preferred site depends on the patient's age, weight, gender, and the degree of muscle development(20). For most infants and toddlers, the vastus lateralis muscle in the anterolateral thigh is the recommended site for injection because it provides a large muscle mass. For children/adolescents who are three years through 18 years the deltoid muscle is recommended. In addition, the vastus lateralis muscle in the anterolateral thigh is an alternative site if the deltoid sites cannot be used for children age 3 through 18 years (19,21). Besides this recommendation, in this review, it has shown that there are the studies in which VG site is safe for intramuscular vaccination in term of the immune response and side effects of vaccines (11,13,14). In line with the results of these studies, more studies are needed to determine the immune response to IM vaccine injection applied to the VG area and the side effects of the vaccine.

Yapucu Gunes et al. (2016) demonstrated that using the WHO injection technique, there was no difference in immune response between the vaccines administered to the vastus lateralis and VG region for hepatitis B vaccine among infants less than 10 months old when a 25-gauge, 16 mm long needle was used (with the skin taut and at a 90-degree angle) (9,12). However, while systemic and local side effects were less common with DTaB (acellular pertussis) and DTPW (whole cell pertussis) vaccinations (14).

Muscle thickness

In our study found that in children 36 months and younger, subcutaneous muscle thickness measurements showed that the deltoid site was thinner than the anterolateral site, and the

anterolateral site was thinner than the VG site (5). The mean thickness of the subcutaneous tissue layer is similar for both the VG area and the anterolateral thigh grafting site at all ages (12). Additionally, the muscle in the VG region is sufficiently developed even in infants aged 1-12 months, and the VG region is thicker than the anterolateral, especially in children aged 12-36 months (12).

Complications of IM injection

The results of this review indicate that using the VG region for IM injections in children is less risky in terms of iatrogenic nerve injury and local and systemic side effects (13). Additionally, it has higher scores in terms of parental acceptability (13). However, its use in nursing practice is not common due to the limited number of evidence-based applications and studies in children, particularly in the use of the VG region. In a study conducted by Yapucu Gunes et al., it was found that the muscle in the VG region is sufficiently developed even in children aged 1-12 months(9). The muscle mass of the region is safer between one and three years of age, with a tendency to be thicker than the vastus lateralis (15). After identifying the VG area using a simple template, it has been observed that it is a more comfortable site for injections (12). This is because the injection process is quick and easy, and children are not able to see the preparation stage. Additionally, it causes less local pain, particularly in children (9).

When comparing the side effects of administering the DBT and Hib vaccines, it was found that injections into the vastus lateralis resulted in significantly higher rates of local reactions such as bruising and redness/swelling, as well as systemic reactions such as irritability, fever, and constant crying/screaming, compared to injections into the VG site. Parental acceptability was demonstrated in all age groups and vaccine groups, with higher acceptability reported for VG injection than for anterolateral thigh injection (13). the VG region is a safe area for Hepatitis B vaccination, with fewer side effects and a positive immune response (11).

Mueller et al. (2012) diagnosed Nikolau Syndrome after applying the fourth dose of DTPa-IPV-HiB-HepB vaccine to the left Vastus Lateralis muscle (18). In addition, our article describes two case reports of injection-related nerve injuries that developed after Vastus Lateralis injection, similar to this study (19,20). It is important to remember that iatrogenic damage to peripheral nerves in children is a common occurrence and can cause serious long-term morbidity. Although there is no guideline regarding the safe location of the IM route, the consensus in the literature is that the VG area is a safe option for the IM route in children (5,9,12,13).

Conclusion

The literature describes that the ventrogluteal area is determined with a simple template, it is a more comfortable application because the injection is easy and fast, children do not see the injection preparation phase, and it causes less local pain, especially in children who can walk. However, it is thought that its use in practice is not widespread due to the limited evidence-based practices in pediatric nursing practice and the limited number of studies in children, especially on the use of the VG region. In line with the results of these studies, more studies are needed to determine safety use of VG for IM injection.

What Study Contributes to Literature

- Contrary to common practice in children, using the VG area for injections is less risky in terms of iatrogenic nerve injury and local and systemic side effects in all age groups.
- The parental acceptability rate for VG region is high.
- Injections administered from the VG region are less anxiety-inducing and frightening for children. This is because the positioning is easier and it is easier to distract their attention.
- In children aged 1 to 3 years, the thickness of the muscle mass in the ventrogluteal region tends to be thicker than that in the vastus lateralis.

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