

# Nontraditional Considerations With Insulin Needle Length Selection

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## ABSTRACT

Ensuring the correct delivery of insulin is essential in the treatment of diabetes. Both proper injection technique and needle length are important considerations for adequate insulin delivery. There have been several studies demonstrating that BMI does not affect efficacy or insulin leakage with shorter pen needles (e.g., 4 or 5 mm vs. 12.7 mm). Additionally, the International Scientific Advisory Board for the Third Injection Technique Workshop released recommendations in 2010 on best practices for injection technique for patients with diabetes, which, with regard to needle length, concluded that 4-mm pen needles were efficacious in all patients regardless of BMI. However, regardless of patients' BMI, insulin injection technique should always be assessed and physically disabling comorbid conditions taken into consideration when choosing a needle length that will be manageable for patients. The purpose of this article is to raise awareness of unique patient circumstances that may warrant the use of the longer 12.7-mm needle.

It has been a long-held belief that obese patients with diabetes need longer needle lengths to penetrate “thicker” layers of subcutaneous tissue and effectively inject insulin. However, many studies have recently been published disputing what now appears to be an outdated school of thought or misconception (1–11). Studies have been conducted evaluating skin thickness, subcutaneous fat thickness, risk of intramuscular injections, insulin leakage, site bruising, pain, lipohypertrophy, and glycemic control. These studies confirm that shorter needle lengths are just as efficacious and safer for patients. Additionally, the International Scientific Advisory Board for the Third Injection Technique Workshop states that there is no medical reason to recommend a needle length longer than 8 mm (1). The board recommends 4-, 5-, and 6-mm needles for

all adult patients regardless of their BMI. It also recommends inserting 4-, 5-, and 6-mm needles at a 90-degree angle and that, if needed, longer needles should be injected with either a skinfold or a 45-degree angle to avoid intramuscular injection of insulin. The shorter needles are less likely to put patients at risk for an intramuscular injection and subsequent erratic glucose absorption (2,3).

Concerns have also been raised that shorter needles increase the risk of insulin leakage, putting patients at risk for unpredictable blood glucose elevations and inappropriate dose adjustments (4). Although the studies to date have not shown conclusively that there is no increase in leakage with shorter needles, the amount of skin leakage seen was comparable to that seen with longer needles. Hirsch et al. (5) demonstrated that patients experienced less injection pain with

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4-mm needles than with 5-mm needles (pain score 11.9 mm less on a 150-mm visual analog scale ranging from -75 mm to +75 mm with zero as the mid-point indicating "no difference") or 8-mm needles (23.3 mm less,  $P < 0.02$ ). All of this evidence supports the argument that the longer 12.7-mm needle should be obsolete. After all, why would a patient intentionally select a long needle when shorter, less painful, needles work just as well (5-7)? Although the evidence clearly demonstrates that shorter needles are just as effective as longer ones in obese patients, this article will illustrate an atypical case in which a longer pen needle is, actually, the preferred option.

### Summary of Evidence Supporting Shorter Needles

#### BMI and Skin Thickness

Needle lengths for subcutaneous injections started out as long as 16 mm in 1985, and 12.7-mm needles were introduced in the early 1990s. Over time, with growing evidence of longer needles increasing risks for intramuscular injections and improved technology, shorter needles of 4, 5, 6, and 8 mm have been developed.

When evaluating skin thickness in 388 patients with BMIs varying from 19.4 to 64.5 kg/m<sup>2</sup>, Gibney et al. (8) found that a 10-kg/m<sup>2</sup> difference accounted for a 4-mm difference in subcutaneous tissue thickness. The average subcutaneous thickness ranged from 10.35 mm to 15.45 mm across all injection sites. This study concluded that 1) the thickness does not vary much between under-, normal-, or overweight individuals and that 2) BMI differences do not cause much variation in the level of skin thickness. The BMI differences were statistically significant but did not make a clinical impact ( $P < 0.001$ ). The skin thickness averages were 1.9–2.4 mm across several different injection sites (i.e., arm, thigh, abdomen, and buttocks), as well as across several BMI levels. With the upper end of skin thickness falling at 2.4

mm, it is logical to assume that a 4-mm needle would be effective in all patients. Therefore, the study further concluded that 4-mm needles would be able to successfully deliver insulin in most adult patients.

A later multisite crossover study by Hirsch et al. (5) supported these conclusions with similar findings. Patients in this study had A1C levels ranging from 5.5 to 9.5% and were randomized into two groups: 1) 32G, 4-mm/31G, 5-mm pen needle group (further separated by low [ $\leq 20$  units] or regular [21–40 units] doses of insulin) or 2) 32G, 4-mm/31G, 8-mm pen needle (also further separated into low- or regular-dose insulin). The patients within each group used the two assigned needles for a 3-week period each. The study did not find a statistically significant difference with change in fructosamine (11–13 mmol/L difference), nor did it find that BMI affected fructosamine changes. (Fructosamine measures glucose concentrations over the previous 2–3 weeks.)

Other studies have also found that patients were able to maintain glycemic control similarly with longer pen needles (12.7 mm) or shorter (5–8 mm) pen needles (9,10). A controlled, multicenter, crossover study by Kreugel et al. (9) specifically evaluated the use of a 31G, 5-mm compared to a 31G, 8-mm pen needle, as well as needle preference for 130 patients with type 1 or type 2 diabetes and a BMI range of 30.1–62.5 kg/m<sup>2</sup> (9). The patients were divided into two groups, and each group used a specific needle length for 3 months before switching to the other needle length for an additional 3 months. Although a favorable, statistically significant difference was found in A1C of 0.12% ( $P = 0.02$ ) between the 5- and 8-mm pen needles, there was no statistical difference between the two groups for fructosamine levels, hypoglycemic episodes, site bruising, or pain perception. Unique to this study is the evaluation of 1,5-anhydroglucitol for possible differences

in postprandial elevations, which found no changes. The patients in this study did not express preference for the 5- or 8-mm needle lengths (46 and 41%, respectively). Schwartz et al. (10) also demonstrated that glycemic control could be maintained with either a 31G, 6-mm or a 29G, 12.7-mm needle in their multicenter, crossover study of 62 patients with type 1 or type 2 diabetes and a BMI range of 30–64 kg/m<sup>2</sup> (10). Similar to the study by Kreugel et al. (9), the patients used one needle length for a 3-month period before switching to the other needle length for an additional 3 months. There was no statistical difference in the final A1C between the two needle lengths (7.6% with the 5-mm needle and 7.9% with the 12.7-mm needle). The study concluded that the two needle sizes provided comparable glycemic control.

Patients in the studies described rated the shorter pen needles as much less painful and, not surprisingly, mostly preferred over longer pen needles (5,10). In the Schwartz study (10), patients also completed several surveys, including the World Health Organization Diabetes Treatment Satisfaction Questionnaire; Insulin Treatment Satisfaction Questionnaire; and, specifically asking questions related to needles, The Needle Handling Questionnaire and the Needle Preference Questionnaire. Their results show that patients reported greater satisfaction ( $P < 0.001$ ) with shorter needles and greater preference for shorter needles (89%,  $P < 0.001$ ) and rated shorter needles more favorably with regard to ease of use, perceived pain, and glycemic control ( $P < 0.001$ ).

#### Insulin Leakage

Despite concern that shorter needles are more apt to cause insulin leakage, especially with larger doses of insulin or with obese patients, the evidence seems to demonstrate the contrary (2,4,5,9,10). In addition to evaluating glycemic control with a 4-mm pen

needle, Hirsch et al. (5) also looked at insulin leakage and concluded that there was no difference between 4-, 5-, and 8-mm needles in the amount of leakage. This study found that 58% of the leaks reported were with the 5- and 8-mm pen needles, and a smaller proportion reported leaks with the 4-mm pen needle. Similarly, the study by Kreugel et al. (9) found no correlation between insulin leakage, BMI, and insulin dose with the 5- versus the 8-mm needles. No comparable difference in the volume of leakage was found between the 6- and 12.7-mm needles (2.7 vs. 3.2 mm) by Schwartz et al. (10).

A difference in leakage, however, was found, although minimal and not clinically significant, when using a vertical injection technique as opposed to an angled technique (65 vs. 59%,  $P < 0.001$ ) with 5-mm needles (2). Additionally, Wittmann et al. (4) found increasing leakage, in absolute terms, with larger doses and shorter needles when various amounts of medium were injected into pork rind. But, once again, comparing the percentage of leakage against the larger volume, the difference was not found to be significant. It can be concluded that shorter pen needles can be used without a significant increase in insulin leakage.

#### **Limitation: Special Populations**

The patients participating in the described studies did not have any physical or cognitive limitations noted. Special populations such as patients with physical limitations that are related to hand movement or dexterity (e.g., osteoarthritis, rheumatoid arthritis, tremors, carpal tunnel syndrome, or tendonitis), the elderly, vision impaired, or pregnant patients may be limited in their capacity to perform accurate self-injections and may require innovative approaches for insulin injection (11,12). Patients with physical limitations or those who use an injection technique in which a shorter needle is not inserted completely, despite education, may

not be ideal candidates for the shorter needles (11). These special circumstances underline the crucial role of diabetes educators in providing diabetes self-management education and support.

#### **Patient Case Highlighting a Unique Situation**

A 63-year-old, morbidly obese (BMI 46.58 kg/m<sup>2</sup>) woman with type 2 diabetes and arthritis presented to the clinic diabetes service with an initial complaint of sporadic yet large-volume insulin leakage from her injection site while using 5-mm pen needles. She was receiving 84 units of insulin glargine twice daily. Her A1C was 7.6%, and her blood glucose log revealed wide glucose excursions (92–371 mg/dL). During the education visit, the patient was able to demonstrate proper injection technique (e.g., angle of injection, complete depression of insulin dose, and appropriate duration of needle insertion). To help reduce insulin leakage, she was counseled to split the dose into two separate injections of 42 units each and provided additional education on injecting the insulin slowly and rotating the injection site.

At her follow-up visit 5 months later, she continued to report significant insulin leakage. Her glucose values continued to show wide excursions ranging from 83 to 354 mg/dL, and her A1C remained at 7.6%. The patient also complained at this visit of her injection site “bubbling up” immediately after the injections.

Taking her BMI into consideration, it was decided that a longer pen needle length may help prevent insulin leakage despite evidence that skin thickness is not increased in obesity (4). Therefore, the patient was switched to an 8-mm pen needle length.

At a 2-week follow-up visit, the patient stated that the insulin leakage improved but was still occurring. She also stated that the needles were often bent when she pulled them out, which she attributed to a “bad

injection site” and scar tissue. Upon reassessment of her injection technique, the patient demonstrated and admitted to always using both hands to deliver the insulin due to her arthritis and decreased mobility. She also stated that she would reinsert the needle in different spots on her abdomen to find a “good spot.”

In addition, unbeknownst to the patient, it was observed that she was unintentionally pulling the needle part of the way out while maneuvering the insulin pen and injecting the insulin. After re-education on injection technique, the patient could not successfully demonstrate a “clean” injection. Her arthritic condition made it challenging for her to use one hand and to keep the needle in while maneuvering and depressing the pen with the other hand awkwardly stretched across her body. Subsequently, she was switched to 12.7-mm pen needles, which, upon repeat demonstration and most likely due to the longer length and 90-degree insertion, stayed in the subcutaneous space despite her unorthodox technique.

Seven months later, the patient confirmed that the leakage problem had resolved and denied any “bubbling up” of the skin, which could possibly be attributed to intradermal delivery of the insulin while the needle was being pulled out. Her A1C increased slightly to 7.8%, but her blood glucose excursions improved (140–260 mg/dL), implying more consistent insulin delivery. After receiving a consistent insulin dose and allowing for proper titration, her A1C improved to 6.7%. No other medications were adjusted, nor were any other medications added or removed.

#### **Practice Implications**

Insulin injection technique directly affects glycemic control, medication adherence, and, ultimately, quality of life. Alarming, an international survey assessing patients on multiple factors related to insulin injection found

that many patients do not recall learning various concepts such as site rotation, mixing insulin, and duration of injection (13). This highlights the need for different approaches to patient education (14).

Diabetes educators are in a key position to ensure that patients receive thorough education and periodic assessments of their injection technique. A teach-back method is an approach that should be employed to confirm proper understanding and technique (15–18). The Institute of Medicine estimates that almost half of the U.S. population has limited health literacy. A plethora of literature describes the negative impact of low health literacy on clinical outcomes of chronic disease states such as diabetes and how communication methods such as the teach-back help improve patient outcomes (16).

In addition to assessing patients' self-injection for appropriate technique and approach (e.g., injection location and injecting through clothing), educators have the responsibility of working together with patients using shared decision-making to select an appropriate and manageable needle length to ensure accurate delivery of insulin. Additionally, injections that are less painful and allow for accurate delivery would most likely help to improve patient motivation for better diabetes self-management and medication adherence. The patient case described here illustrates just one example of a unique circumstance inhibiting successful use of a shorter pen needle.

### Conclusion

Studies have demonstrated that BMI does not affect efficacy of particular needle lengths, and consensus panels have published guideline recommendations supporting shorter needles.

Nonetheless, this article describes a situation in which insulin delivery and, ultimately, glycemic control was improved with a longer pen needle length, demonstrating that there may be unique circumstances in which a longer pen needle should be used (1,5,8–11). Longer pen needles may be a better option for some patients with higher BMIs and coordination challenges resulting from comorbid health conditions such as arthritis. Although shorter needle lengths should be the standard, diabetes educators and providers should assess their appropriateness and effectiveness on a case-by-case basis and still consider longer needles when needed.

### Duality of Interest

No potential conflicts of interest relevant to this article were reported.

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