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ORIGINAL RESEARCH

Barriers to the Prevention of Insulin Injection-Associated Lipohypertrophy for Individuals with Diabetes

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Aims and Objectives: This study aimed to explore barriers to preventing lipohypertrophy for individuals with diabetes.

Design: A qualitative descriptive design was used.

Methods: 17 individuals with diabetes with LH were interviewed face-to-face in individual semi-structured interviews. Qualitative content analysis was used, and data saturation was achieved.

Results: The analysis yielded three primary themes with eight subthemes: lack of knowledge (insufficient health education, forgetfulness, and misconceptions), limited feasibility (several limitations in site rotation, financial pressures in needle replacement, and failure to self-monitor flat LH), and low motivation (low perceived severity and low perceived susceptibility).

Conclusion: Identifying these barriers provides patients with targeted recommendations or measures to improve LH prevention, further improving self-management at home and diabetes outcomes.

Relevance for Clinical Practice: LH is a common insulin therapy complication that affects insulin absorption and glycemic control. The correct injection technique for preventing LH depends on the effectiveness of insulin therapy in individuals with diabetes.

Patient or Public Contribution: 17 individuals with type 2 diabetes who participated in the interviews contributed to this study.

Keywords: insulin injection-associated lipohypertrophy, barriers, diabetes, qualitative study

Introduction

Diabetes mellitus (DM) represents a major global health challenge, affecting approximately 537 million adults aged 20–79 years worldwide, accounting for 10.5% of the global population.[1] In China, the overall diabetes prevalence stands at 12.4%, exceeding global rates, with over 140 million affected individuals. While all type 1 diabetes patients require exogenous insulin therapy, approximately one-third of type 2 diabetes patients also depend on insulin for glycemic control.[2]

Lipohypertrophy (LH), the most prevalent local complication of insulin injections, manifests as subcutaneous nodular swelling due to adipose tissue proliferation at injection sites, occurring in 41.8% of cases on average.[3] The mechanism of LH is not clear yet, but it could be attributable to insulin's anabolic effects on regional adipose tissue, repeated injection-induced subcutaneous tissue trauma, and subsequent repair processes.[4] Insulin pharmacokinetics studies showed that injection at the LH sites significantly impairs insulin absorption, resulting in marked hyperglycemia,[5] and the continuous deterioration of blood glucose in patients leads to a larger total daily dose of insulin. Once a large dose of insulin is injected into normal tissues, it substantially increases hypoglycemia risk. These

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clinical consequences contribute to elevated healthcare expenditures.[6] Therefore, preventing and regularly monitoring LH is indispensable. While conventional detection methods rely on visualization and palpation, Conventional diagnostic approaches primarily rely on visual inspection and palpation; however, these methods exhibit limited effectiveness in detecting flat LH lesions. The pinching maneuver can aid in identifying less visible, elastic nodules, yet it remains challenging for patients without professional training to perform accurately.[4] In contrast, ultrasound examination emerges as a superior diagnostic modality, offering enhanced sensitivity and specificity compared to physical assessment, particularly for non-palpable LH.[7] Additionally, ultrasound examination facilitates precise identification of optimal injection sites in patients with LH concerns.[8] However, there is a lack of routine LH examinations for outpatient and hospitalized individuals with diabetes in hospitals in China. Considering the serious outcomes and the delays or lack of routine LH monitoring, patients need to put more emphasis on LH prevention for long-term self-management of DM at home.[9,10]

International guidelines for preventing insulin injection-associated LH are available.[11] Optimal insulin injection practice requires: systematic avoidance of LH-affected areas, adherence to rotational protocols maintaining ≥1 cm spacing between injections, and proper technique application across recommended sites (abdominal wall, lateral/posterior arms, anterolateral thighs, and buttocks), the use of cold insulin should also be avoided, the use of shorter needles (4 mm) with single-use disposable needles.[4] The efficacy of LH prevention in individuals with diabetes is contingent upon properly implementing preventive measures.[12–14] However, current LH prevention practices remain suboptimal. Epidemiological evidence reveals significant gaps in patients' knowledge and technical competence regarding insulin injection techniques.[15] Particularly concerning is the observation that patients frequently inject into LH-affected areas while demonstrating improper site rotation and excessive needle reuse (≥3 times).[16,17]

Injecting insulin into an area of LH significantly alters its pharmacokinetic profile.[18] Despite growing clinical awareness of LH prevention, studies exploring the implementation barriers comprehensively and systematically remain limited. This knowledge gap is particularly pronounced in China's home-based diabetes management context. Furthermore, patients with existing LH likely encounter more complex prevention challenges. Therefore, this qualitative study was designed to comprehensively identify barriers to LH prevention through in-depth interviews with affected patients.

Methods

Design

The study used a qualitative descriptive design. Between June and August 2024, 17 patients with LH were interviewed semi-structured. The Consolidated Criteria for Reporting Qualitative Studies (COREQ)[19] reporting guidelines were used (Supplementary file 1).

Participants

Participant selection was based on the following criteria. Patients were eligible if they (1) had a diagnosis of diabetes mellitus and received insulin therapy, (2) had LH by ultrasound examination; (3) injected insulin at home before this admission; and (4) volunteered to participate in this study. Patients were excluded if they (1) had a medical record of severe psychiatric or cognitive disorders, or (2) were unable to participate in interviews for any reason. Participants were recruited through purposive sampling. The research team provided free ultrasound examinations for all individuals with diabetes who receive insulin therapy in the endocrinology department of a hospital in Changsha, China. After exanimation, the research team confirmed the eligibility of all patients with LH according to inclusion and exclusion criteria, and 25 eligible patients with LH were identified. Those potential participants were invited to participate in the study individually, and the interviews were only stopped once new themes were developed. Finally, three eligible patients refused to participate in this study due to a shortage of time, and 17 participants finished the interview when the information saturation was achieved.

Table 1 General Information Questionnaire

Number	Age	Gender	Diabetes Type	Duration of Insulin Therapy (Year)	Times of Injection per Day
1	48	Male	Type 2 diabetes	3	4
2	47	Male	Type 2 diabetes	5	4
3	57	Male	Type 2 diabetes	4	4
4	63	Female	Type 2 diabetes	8	4
5	66	Female	Type 2 diabetes	9	4
6	39	Male	Type 2 diabetes	5	4
7	51	Male	Type 2 diabetes	3	4
8	61	Female	Type 2 diabetes	8	4
9	59	Male	Type 2 diabetes	15	4
10	58	Female	Type 2 diabetes	7	4
11	65	Male	Type 2 diabetes	9	4
12	70	Female	Type 2 diabetes	12	4
13	47	Female	Type 2 diabetes	4	4
14	54	Male	Type 2 diabetes	8	4
15	63	Male	Type 2 diabetes	6	4
16	56	Male	Type 2 diabetes	7	4
17	50	Female	Type 2 diabetes	10	4

Data Collection

Face-to-face semi-structured interviews were conducted in a separate, quiet room in the endocrinology department. No one was present during the interview besides the participant and the interviewer. Before the interview, interviewees were asked to finish a short general Information Questionnaire shown in Table 1. A semi-structured interview guide (Figure 1)

Number	Questions
1	Do you know about LH and its dangers?
2	Do you know the preventive measures for LH?
3	What precautions HCPs tell you are effective for LH?
4	How do you usually rotate injection sites at home? Do HCPs inform you about rotate injection sites and how to do that? What barriers do you have in site rotation? (Why you don't do that?)
5	What type of needle do you usually use at home? Do the HCP tell you the optimal type of needle? What barriers do you have in using 4mm needles? (Why you don't do that?)
6	How many times do you usually use a needle at home? Do the HCP tell you the optimal frequency of needle use? What barriers do you have in change a new needle every time? (Why you don't do that?)
7	Do you usually check for LH by visualization or palpation? Do HCPs inform you about checking for LH and how to do that? What barriers do you have in checking for LH at home? (Why you don't do that?)
8	Did you know you had LH before the ultrasound and have you injected at the LH site in the last month? Do HCPs inform you about not injecting at the LH site? What barriers do you have in checking for LH at home? (Why you don't do that?)

Figure 1 Interview guide. The interview guide was used in in-depth interviews with 17 patients with LH. It contained open-ended questions designed to elicit patient perspectives on barriers or challenges related to preventing LH.

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was used and was not pilot tested. An audio recorder recorded the entire interview. Conducted interviews ranged from 20 to 60 minutes duration, with verbatim transcription completed within 24 hours. Participants received interview summaries for factual verification to ensure data accuracy and address potential discrepancies.

Data Analysis

All participants were assigned numeric identifiers (P1-P17), with personally identifiable information redacted from transcripts to ensure confidentiality. Following Braun and Clarke's methodology,[20] thematic analysis was performed to systematically identify, evaluate, and synthesize patterns within the qualitative dataset. The six-phase analytical process[21] was also used to interpret the raw data: (1) familiarizing oneself with the data, (2) generating codes, (3) constructing themes, (4) reviewing potential themes, (5) defining and naming themes, and (6) producing the report. NVivo 8 was used to manage the data. The data analysis was stopped after data saturation was reached. In total, three major themes and eight subthemes were derived.

Ethics

Institutional Review Board approval was obtained from Xiangya Nursing School, Central South University (E202414). Participants were asked to read the information in detail to understand the purpose and content of the interview, as well as the risks and benefits of participating in this study. They were informed that they could withdraw from the study without any negative consequences. They were also informed that the interview was audio-recorded and that the data would be anonymized and stored in an encrypted database. The informed consent form which included publication of anonymized responses/direct quotes was signed by all participants, who also agreed to the publication of anonymized results. This study complies with the Declaration of Helsinki.

Research Team and Reflexivity

A female interviewer (the first author) conducted the interviews. She was a nurse with a Master's degree and had received training in qualitative research. Researcher-participant rapport was established during recruitment, with participants receiving interviewers' relevant professional background information, such as their credentials, occupations, and reasons for doing this research.

Results

General Information About the Study Population

The study comprised 17 participants (10 males, seven females) who completed in-depth interviews. Demographic characteristics revealed a mean age of 56.1±8.3 years and a mean insulin therapy duration of 7.2±3.2 years. All participants have type 2 diabetes and receive insulin injections four times a day. The detailed information is shown in Table 1 below.

Major Themes and Subthemes

Through an iterative analysis of transcripts from 17 individuals with diabetes, three major themes were identified: lack of knowledge (insufficient health education, forgetfulness and misconceptions), limited feasibility (several limitations in site rotation, financial pressures in needle replacement, and failure to self-monitor flat LH), and low motivation (low perceived severity and low perceived susceptibility).

Lack of Knowledge

Insufficient Health Education

No patient knows all the preventive measures of LH. Some patients are not told about LH or some preventive measures, mainly lacking knowledge about site rotation and monitoring LH.

P7: When I was hospitalized before, they (HCPs) did not tell me about LH, which you just mentioned.

P10: The HCPs asked me to rotate the injection site, but they did not say how to do it clearly. I do not know how to do it; in fact, I did not rotate the injection site by following some rules.

P2: They (HCPs) told me to change a new needle and rotate the injection site, but I do not know that those measures are aimed to prevent LH. …… I do not know how to monitor LH and seldom check my skin.

Forget

Some patients were told about some preventive measures for LH in the hospital, but they did not master or forget the information after discharge. One-time education at discharge may be insufficient to bring about a satisfactory outcome.

P8: When I was discharged from the hospital, they (HCPs) taught me a lot, but there was some knowledge I did not remember and forgot some when I went home.

P4: Their (HCPs) speed was fast, and I could not make sure that I mastered all the knowledge about diabetes in a short time.

Misconceptions

In reality, some patients have misconceptions about health information. For example, some patients frequently inject insulin at lipohypertrophic areas on purpose due to less pain. Another misconception is that rotating the site is to keep the needle tips from overlapping.

P7: I do not know about this issue of LH. I always inject in this area (lipohypertrophic areas) because it does not hurt, but it hurts when I inject in the rest of my abdomen.

P11: I use my left hand to inject insulin every time, and the most convenient location is the left side of my abdomen. The needle tips are so small that they will not overlap no matter how randomly I inject it into my abdomen.

Low Motivation

Low Perceived Severity

Understanding the adverse effects of LH can lead to less emphasis on LH management and reduced incentives to engage in essential preventive behavior. Some patients are unaware of LH's dangers or the significance of preventive measures. Therefore, their compliance with such measures is relatively low.

P1: They (HCPs) told me to rotate the sites for injections and change needles, but they also did not tell me that those were aimed at avoiding LH and its adverse effects. I did not realize that until you said it.

P5: I have never had a skin ultrasound before and do not know I have an LH. If I knew that LH has so many harmful effects, I would pay more attention to the site rotation than before.

P15: Now that I know the dangers of LH, I will definitely be more careful after I am discharged from the hospital and will not repeat the injections in the same place.

Low Perceived Susceptibility

Some patients do not perceive the immediate adverse effects of not obeying the preventive measures, and their belief about the likelihood of getting an LH decreases their motivation to comply with preventive measures.

P11: I change this needle once a day, and I inject insulin 4 times a day. The nurse told me to change it one at a time, but I have not had any bad problems with reusing it.

P13: Is this problem that serious? I often inject in this area (LH), and I do not feel any significantly harmful changes in myself.

Feasibility Limitations

Several Limitations in Site Rotation

Rotation of injection sites can be limited by the availability of a caregiver, secret location, season, and clothing. It is easier for patients wearing T-shirts or trunks to expose their thighs and arms in the summer, whereas in the fall and winter, skin exposure of the thighs and arms is more problematic when patients wear more clothing. Besides, injections in the arm and buttocks need the caregiver's assistance, and injections in the buttocks are less convenient than other sites because exposure of the buttocks may involve privacy issues and needs to be done in a secluded place. As a result, injections in the abdomen are most common.

> P4: I did not strictly rotate the injection sites as the nurse said because it was most convenient to inject in the abdomen. I pulled up my shirt when injecting in the abdomen, which was the most convenient, so I injected in the abdomen the most. Injecting in the thighs, buttocks, and arms was inconvenient. I took care of myself, and it was not possible to inject in the buttocks and arms without help.

> P8: The location of the injections is also related to the season. In the summer, when I wear short-sleeved shirts and shorts, I inject on my thighs, or someone else injects insulin on my arms for me. However, in winter, when I wear many clothes, injecting on my abdomen is still the most frequent.

> P17: I know I should rotate the parts of my body, but sometimes I cannot. When I eat out, I inject on my abdomen mostly, and it is not convenient for me to inject on other parts of my body. If injecting in the buttocks or thighs, I have to find a secret place, and that is troublesome.

Financial Pressures in Needle Replacement

Some patients use one needle to inject four times in one day or even longer. Almost no one uses a needle only once. Financial pressures mainly restrict needle replacement. Changing a new needle for every injection will increase costs in the long term.

> P4: Changing the needle every time I use it is troublesome and wasteful.

> P13: I inject insulin 4 times a day; if I change a new needle every time, it is pretty expensive, so I cannot change it every time.

Failure to Self-Monitor Flat LH

Some flat LH could not be detected by visualization and palpation during the patient's homestay. The pinching maneuver which can aid in identifying less visible, elastic nodules may be challenging for patients without professional training to perform accurately. Failures in self-monitoring make it difficult to keep patients from injecting in flat LH unintentionally.

> P9: The doctor did not monitor LH at any of my previous hospitalizations, and I have been injecting in these sites (LH) without noticing it.

> P16: I did not know I had LH until now (an ultrasound examination), but I could not find LH at home.

Discussion

LH prevalence is related to many factors, including diabetes duration and time of insulin use, reuse of needles, non-rotation of the injection site, dose of insulin use, HbA1c (%) level, needle length, and injection times/day.[4] In this study, we only focus on the barriers to implementing changeable preventions of LH. As diabetes is mainly self-managed at home and insulin injections are operator-dependent, a deep understanding of injection techniques and adherence to those preventions are critical for patients and their caregivers to achieve a desirable outcome in diabetes management.[14]

Insulin injection sites need to be rotated systematically and structured, with a minimum distance of 1 cm between injections, to avoid reusing the same injection site within a month.[4] The lack of knowledge and limited feasibility within this study restrict the implementation of standardized injection site rotation. Some patients were not told how to rotate the

injection site systematically and structuredly, and insulin injection sites tend to be chosen randomly. They even wrongly thought that site rotation is to keep the needle eyes on the skin surface, not overlap. Numerous studies have demonstrated that incorrect site rotation is common and that health education directly improves it.[17,22] HCPs should provide them with instructions about LH. In terms of feasibility, injections in the abdomen are the most convenient for skin exposure and without requiring assistance from a caregiver or a secret location. Individualized and systematic rotation plans should be developed according to the patient's circumstances, such as caregiver availability, season, and clothing, and be reviewed by HCPs periodically.

Using 4mm needles is feasible for every patient as needles of smaller bore sizes and shorter lengths (4.0 mm) are currently used among patients. Our study shows a satisfactory phenomenon: all participants use 4.0 mm needles and are less likely to form LH daily. However, needle replacement is worrisome as few patients use a new needle when they inject insulin. Some patients use a needle several times mainly because frequent needle replacement incurs heavy medical costs. This phenomenon is widespread among people with diabetes in China because needles are not covered by medical insurance in some province.[23] Financial pressure in needle replacement is a structural challenge in LH prevention and requires more government involvement and investment.

Good injection techniques also include not injecting into lipohypertrophic areas. In this study, some patients did not know this and intentionally injected at the LH sites frequently due to pain relief, which is a common misconception among diabetic people[24] and must be clarified by HCPs. In addition, flat LH could not be detected by visualization and palpation and it is difficult for patients to perform accurate pinching maneuver to detect flat LH, and ultrasound could not be performed during the patient's homestay. Patients who cannot monitor LH effectively inject at lipohypertrophic sites unintentionally. This phenomenon highlights the importance of preventing and self-monitoring LH.[25] Ultrasound examination for LH in individuals with diabetes was not widely available for patients in Chinese communities and hospitals due to a shortage of specialized staff and high expenses. HCPs should educate patients on monitoring LH by themselves using visual and palpable examinations and move forward with ultrasound examinations at least once annually as a diabetes management routine.

This study found that individuals with diabetes have insufficient knowledge about LH at discharge and tend to forget it after discharge. The health education they received was only once and was inadequate. HCPs who provide structured health education about LH play an important role in compensating for patients' lack of knowledge to prevent LH.[25] However, few organizational resources (dedicated staff, pathways, and time), and in some countries, no pay for health education results in inadequate education in LH.[24] An economical and easily adaptable educational method should be developed; for example, patients should be provided with videos and manuals about LH. Health education about preventing LH for individuals with diabetes should continuously provide comprehensive knowledge to improve understanding and memorization, especially for elderly patients with low literacy. Multi-stage health education at admission, discharge, and post-discharge may be important in preventing LH in individuals with diabetes.[12] Studies show that individualized and intensive injection technique education considerably leads to better glycemic control, increased therapeutic adherence, and drastically reduced costs related to their clinical consequences.[8,26]

In this study, individuals with diabetes with low motivation caused by low perceived susceptibility and perceived severity are concerned. On the one hand, some individuals with diabetes are not told the harms of LH. On the other hand, the formation of LH is a long-term process, and the glycemic variability caused by LH is hard to prove in non-experimental conditions, which leads to low perceived susceptibility. According to the health belief model, perceived susceptibility and perceived severity upgrade people's awareness and attitude and facilitate self-care behaviors.[27] The motivation and adherence of individuals with diabetes to LH prevention are poor due to underestimation of the likelihood of getting an LH and the seriousness of its consequences. To overcome this issue, HCPs should emphasize the danger of LH and the significance of preventing LH. In addition, experimental data and animation demonstrations can be used to increase the motivation and adherence of patients to prevent LH.

Limitation

This study has several limitations. As a qualitative descriptive inquiry, it does not seek to establish causal relationships between variables, and the results are not intended to be statistically generalizable to the broader population of insulin

users. Additionally, this study presents only a single perspective—that of individuals with diabetes—regarding barriers to implementing LH prevention strategies at home. It does not examine potential facilitators, which are critical for designing effective interventions. The participant sample was also limited to patients using an insulin pen from a single hospital in China, thereby excluding the experiences of individuals using continuous subcutaneous insulin infusion (insulin pumps) as well as those from diverse geographical or care settings. Consequently, the findings may not fully represent the challenges faced by pump users or account for variations in socioeconomic, cultural, or healthcare systems across different regions. Furthermore, although key themes were identified, we acknowledge the potential influence of psychosocial factors that may affect LH prevention. Future research should incorporate multiple stakeholders, including healthcare providers and caregivers, to obtain a comprehensive understanding of both barriers and facilitators. Quantitative or mixed-methods designs are recommended to generalize findings, test hypotheses derived from this study, and develop tailored strategies for improved LH management.

Conclusion

This study interviewed diabetic inpatients with LH at a hospital in China to explore the barriers to implementing LH preventive measures at home. Identifying these barriers provides patients with targeted recommendations or measures to improve LH prevention. Guidance for implementing LH precautions further improves self-management at home and diabetes outcomes. As a whole, patients' awareness of the importance of LH needs to be improved. HCPs should strengthen health education on LH to compensate for the lack of knowledge and motivation. Comprehensive and detailed information that could prompt effective education on LH should be shown in diverse forms like verbal instructions, brochures, and videos and be repeated at admission, discharge, and after discharge. In terms of feasibility, the government or healthcare centers should strive to promote cheaper or even free needles and establish regular monitoring of LH as a part of diabetes management. Individualized and systematic rotation plans should suit the patient's circumstances and be reviewed by HCPs.

Ethics

Institutional Review Board approval was obtained from Xiangya Nursing school, Central South University (E202414).

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

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