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# Incidence of lipohypertrophy in diabetic patients and a study of influencing factors

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**Abstract**

This study examines the incidence of lipohypertrophy in diabetic individuals as well as the factors that have an influence on causing this condition. In consideration of the period of development of lipohypertrophy, the research sampling consisted of 215 diabetics who had been using insulin for at least 2 years. Observation and palpation techniques were used in assessing lipohypertrophy in these diabetics. Data were evaluated using percentages, $\chi^2$ and logistic regression analysis. Results of the study established lipohypertrophy in 48.8% of the individuals comprising the sampling. It was seen that the incidence of lipohypertrophy in these individuals was affected by their level of education, the frequency that they changed needles, the frequency of changing their injection sites and the amount of time they had been using insulin, the difference proving to be statistically significant ($p < 0.05$). In the logistic regression analysis, it was found that the amount of time insulin had been used ($p = 0.001$), the frequency of changing injection sites ($p = 0.004$) and the frequency of changing needles ($p = 0.004$) had an influence on the development of lipohypertrophy. These results show that the amount of time insulin is used and the procedure for injection both affect the development of lipohypertrophy.


*Keywords:* Lipodystrophy; Lipohypertrophy; Insulin management; Rotation of injection site

## 1. Introduction

With the technological advances creating changes in living conditions in the last 20 years, there has been an increase observed both in the number of patients diagnosed with diabetes and in the number of insulin users. With this rise in the subcutaneous use of insulin, dermatological complications related to treatment have come to the fore. One of these dermatological complications is lipohypertrophy, which is defined as the changes that develop in the fat tissue caused by injections of insulin [1].

The incidence of lipohypertrophy is so high as not to be ignored. In studies conducted on Type 1 diabetic patients, Kordonouri et al. [2] reports an incidence of 48%, Partanen and Rissanen [3] an incidence of 34.5%, and Raile et al. [4] an incidence of 27.1% of lipohypertrophy in their patients. In addition, McNally et al. discloses an incidence of lipohypertrophy of 28% in Type 2 diabetic patients while Teft speaks of an incidence of lipohypertrophy of 57% in both Type 1 and Type 2 diabetics [5,6]. Hauner et al. as well have established an incidence of 28.7% in Type 1 diabetic patients, reporting at the same time that this proportion drops to 3.6% in Type 2 diabetics [7].

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A look into the literature reveals that lipohypertrophy is mostly seen in Type 1 diabetics [2–4,6,7]. The factors influencing the development of lipohypertrophy have been cited as the amount of time insulin has been used, the number of daily injections, gender, body mass index (BMI), injection sites, rotation of sites, the use of pens as opposed to syringes, the length of the needle and the frequency needles are changed [2–10].

Early diagnosis of lipohypertrophy is very important. Pain sensations diminish in areas where lipohypertrophy has formed and for that reason diabetic patients prefer to always administer their injections in the same site. As a result, lipohypertrophic tissue increases. Because insulin absorption is restricted in the area where lipohypertrophy has developed, the risk of hyperglycemia arises [8,9,11–13]. Partanen and Kordonouri have shown in their research that metabolic control is poor in patients with lipohypertrophy [2,3]. Since these diabetics with lipohypertrophy have poor metabolic control, they are at risk of developing complications. It has been established that when a portion of the insulin injected into an area with lipohypertrophy cannot be absorbed, not only will there be the danger of hyperglycemia but conversely, when the same dose of insulin is injected into an area without lipohypertrophy, the insulin will be completely absorbed and the risk of hypoglycemia will then emerge [5,13–15].

It has been indicated that health-care providers and patients do not take this important problem seriously and consequently fail to have control over this situation [6,10]. It is very important in the treatment of diabetes that these complications be warded off through the correct application of insulin, the inevitable element in diabetic treatment. In the case of lipohypertrophy, it is vital that this condition is recognized so that the treatment can be readjusted. It is for this reason that diabetic care-providing nurses play a major role in treatment. Both healthcare personnel and diabetic individuals should be aware of the significance of lipohypertrophy, seek its early diagnosis and know what the risk factors involved are. Learning about how frequent lipohypertrophy is seen in patients and the factors that influence the condition will be valuable guidelines to follow for both diabetic patients and their nurses. So this study was planned as definitive research, designed to determine the incidence of lipohypertrophy in diabetic patients as well as the factors influencing the condition.

## 2. Materials and methods

### 2.1. Subjects and design

The work was conducted during the period 5 August 2004–15 January 2005 at Dokuz Eylül University Medical School Hospital and at the Ege University Medical School Hospital. The sampling comprised 215 diabetics who applied to the adult endocrinology polyclinics of these two university hospitals.

Considering the period of development of lipohypertrophy, patients were chosen who had been using insulin for at least 2 years and had consented voluntarily to be included in the research [7]. None of the diabetic individuals were using syringes; all of them were using insulin pens. The essential clinical characteristics are summarized in Table 1.

Contact was made with the Endocrinology Departments of the Dokuz Eylül University and Ege University Medical School Hospitals and the necessary permissions were obtained.

Data were collected by the researcher through the method of face-to-face contact. The questionnaire was prepared after a study of relevant literature and following suggestions given by the advisor.

Table 1
Clinical characteristics of study populations ($n = 215$) [age ($X = 59.6$)]

| | Number | % |
|---|---|---|
| Gender | | |
| Women | 137 | 63.7 |
| Men | 78 | 36.3 |
| Education | | |
| Elementary | 93 | 43.3 |
| High School | 86 | 40 |
| University | 36 | 16.7 |
| BMI | | |
| Normal | 72 | 33.5 |
| Overweight | 86 | 40 |
| Obese | 57 | 26.5 |
| Needle change frequency | | |
| At every injection | 74 | 34.5 |
| At every two–three injections | 82 | 38.1 |
| At every four–five injections | 48 | 22.3 |
| When cartridge is finished | 11 | 5.1 |
| Length of needle | | |
| 8 mm | 164 | 76.3 |
| 5 mm | 51 | 23.7 |
| Change of site frequency | | |
| A different site at every injection | 39 | 18.1 |
| A week at each site | 126 | 58.6 |
| Haphazardly | 21 | 9.8 |
| Using only one site | 29 | 13.5 |
| Duration of insulin use | | |
| 0–5 years | 66 | 30.7 |
| 6–10 years | 59 | 27.4 |
| 11–15 years | 57 | 26.5 |
| 16–20 years | 33 | 15.4 |
| Diabetes type | | |
| Type 1 | 31 | 14.4 |
| Type 2 | 184 | 85.6 |

### 2.2. Variables of study

The study's dependent variable was the observation of lipohypertrophy in diabetic patients. Independent variables were gender, education, body mass index, frequency of needle change, needle length, frequency of changing site, and length of insulin use.

### 2.3. Assesment of lipohypertrophy

Observation and the palpation technique were used in assessing lipohypertrophy in diabetic individuals. Lipohypertrophy was assessed as either "present" or "not present".

Lipohypertrophy present: The presence of a noticeable or palpable/unpalpable lump on the injection site.

Lipohypertrophy not present: No difference in the injection site [2,4].

### 2.4. Statistical analysis

Data were assessed using an SPSS package program. Clinical characteristics of study populations was evaluated using percentages. The factors influencing lipohypertrophy and the development of lipohypertrophy were evaluated using $\chi^2$-test. Independent variables influencing the occurrence of lipohypertrophy was evaluated logistic regression analysis.

## 3. Results

The factors affecting lipohypertrophy and the status of lipohypertrophy in the 215 diabetics included in the study have been shown in Table 2.

### 3.1. Influence of individual characteristics of diabetics on the development of lipohypertrophy

#### 3.1.1. Gender

Of the cases diagnosed as lipohypertrophy, 50.45% were women and 44.9% were men. No statistically significant difference was found between the gender of diabetic individuals and the incidence of lipohypertrophy ($p > 0.05$).

#### 3.1.2. Education

While the proportion of elementary school graduates with lipohypertrophy was 58.1%, 44.2% were high school graduates and only 33.3% were university graduates. The difference was found to be statistically significant ($p < 0.05$). Advanced analysis showed that this difference stemmed from the elementary school graduate group that displayed the most incidence of lipohypertrophy. As the level of education increased it was found that the proportional incidence of developing lipohypertrophy fell. Logistical regression analysis, however, showed that education was a negligible factor in the development of lipohypertrophy.

#### 3.1.3. Body mass index

Lipohypertrophy was found in 40.3% of individuals classified as having a normal body mass index. It was seen in 57% of overweight individuals and in 45.6% of those defined as obese. The difference between body mass index classification in diabetics and the incidence of lipohypertrophy was not found to be statistically significant ($p > 0.05$).

#### 3.1.4. Needle change frequency

While lipohypertrophy was observed in 20.3% of diabetics who changed their needle at every injection, this proportion was 51.2% in those who changed needles every two–three injections, 75% in those that changed every four–five injections and 100% in those that changed only when the cartridge was finished. A statistically significant difference was seen between needle change frequency in diabetics and the incidence of lipohypertrophy ($p < 0.05$). Advanced analysis showed that this difference stemmed from the group that changed needles at every injection, where lipohypertrophy was seen the least. It has thus been observed that using the same needle more than once increases the risk of lipohypertrophy.

#### 3.1.5. Length of needle

Lipohypertrophy was seen in 47.6% of the 164 diabetics in the study who were using an 8 mm needle and in 51% in the 51 diabetics who were using a 5 mm needle. No statistically significant difference was seen between the length of needle used by diabetics and the incidence of lipohypertrophy ($p > 0.05$).

#### 3.1.6. Change of site frequency

While lipohypertrophy was seen in 76.9% of the diabetics who changed injection sites at each injection, the condition was seen in 86% of the persons who used only one injection site. Lipohypertrophy was also observed in 90.5% of persons who chose the injection site at random. Lipohypertrophy was seen in only 23.8% of persons who rotated the injection site weekly. A statistically significant difference was seen ($p < 0.05$) in diabetic individuals between the occurrence of lipohypertrophy and the frequency of their changing the injection site. Advanced analysis showed that the difference stemmed from the group of patients that had been rotating the injection site weekly.

Table 2
Factors influencing lipohypertrophy and the status of lipohypertrophy

| | Lipohypertrophy status | | | | | | |
|---|---|---|---|---|---|---|---|
| | Present | | Not present | | Total | | |
| | Number | % | Number | % | Number | % | |
| Gender | | | | | | | |
| Women | 69 | 50.4 | 68 | 49.6 | 137 | 100.0 | 0.43837 ($p > 0.05$) |
| Men | 35 | 44.9 | 43 | 55.1 | 78 | 100.0 | |
| Education | | | | | | | |
| Elementary | 54 | 58.1 | 39 | 41.9 | 93 | 100.0 | 0.02520 ($p < 0.05$) |
| High School | 38 | 44.2 | 48 | 55.8 | 86 | 100.0 | |
| University | 12 | 33.3 | 24 | 66.7 | 36 | 100.0 | |
| BMI | | | | | | | |
| Normal | 29 | 40.3 | 43 | 59.7 | 72 | 100.0 | 0.09965 ($p > 0.05$) |
| Overweight | 49 | 57 | 37 | 43 | 86 | 100.0 | |
| Obese | 26 | 45.6 | 31 | 54.4 | 57 | 100.0 | |
| Needle change frequency | | | | | | | |
| At every injection | 15 | 20.3 | 59 | 79.7 | 74 | 100.0 | 0.0000 ($p < 0.05$) |
| At every two–three injections | 42 | 51.2 | 40 | 48.8 | 82 | 100.0 | |
| At every four–five injections | 36 | 75 | 12 | 25 | 48 | 100.0 | |
| When cartridge is finished | 11 | 100 | – | – | 11 | 100.0 | |
| Length of needle | | | | | | | |
| 8 mm | 78 | 47.6 | 86 | 52.4 | 164 | 100.0 | 0.66954 ($p > 0.05$) |
| 5 mm | 26 | 51 | 25 | 49 | 51 | 100.0 | |
| Change of site frequency | | | | | | | |
| A different site at every injection | 30 | 76.9 | 9 | 23.1 | 39 | 100.0 | 0.0000 ($p < 0.05$) |
| A week at each site | 30 | 23.8 | 96 | 76.2 | 126 | 100.0 | |
| Haphazardly | 19 | 90.5 | 2 | 9.5 | 21 | 100.0 | |
| Using only one site | 25 | 86.2 | 4 | 13.8 | 29 | 100.0 | |
| Duration of insulin use | | | | | | | |
| 0–5 years | 8 | 12.1 | 58 | 87.9 | 66 | 100.0 | 0.0000 ($p < 0.05$) |
| 6–10 years | 24 | 40.7 | 35 | 59.3 | 59 | 100.0 | |
| 11–15 years | 44 | 77.2 | 13 | 22.8 | 57 | 100.0 | |
| 16–20 years | 28 | 84.8 | 5 | 15.2 | 33 | 100.0 | |

### 3.1.7. Duration of insulin use

While lipohypertrophy was seen in only 12.1% of the diabetics in the study who had been using insulin for less than 5 years, this proportion was 40.7% in those who had been using insulin for 6–10 years, 77.2% in those using insulin for 11–15 years and 84.8% in users of 16–20 years. A statistically significant difference ($p < 0.05$) was seen between the occurrence of lipohypertrophy and the duration of use of insulin in diabetic individuals. Advanced analysis showed that the difference stemmed from the group that had been using insulin for 0–5 years.

A logistic regression analysis was carried out to determine which of the four variables that proved to be significant in this study, conducted to establish the incidence of lipohypertrophy in diabetics and the factors having an influence on this condition, had an effect on the occurrence of lipohypertrophy (Table 3). The analysis showed that the effect of education was not statistically significant. The duration of insulin use ($p = 0.001$), the frequency of changing needles ($p = 0.004$) and the frequency of changing sites ($p = 0.004$), however, were found to be statistically significant.

Table 3
Logistic regression analysis of independent variables influencing the occurrence of lipohypertrophy

| Variables | *B* | *P* | OR | 95% CI |
|---|---|---|---|---|
| Education | −0.345 | 0.333 | 0.709 | 0.353–1.424 |
| Frequency of needle change | 1.036 | 0.004 | 2.819 | 1.403–5.662 |
| Frequency of site change | 1.303 | 0.004 | 3.682 | 1.531–8.855 |
| Duration of insulin use | 1.172 | 0.001 | 3.228 | 1.636–6.366 |

## 4. Discussion

The most common local complication seen in diabetic individuals treated with insulin is lipohypertrophy. This study has revealed that the factors influencing the development of lipohypertrophy are the duration of insulin use, the frequency of changing needles, and the frequency of changing injection sites.

As the duration of insulin use increases, the incidence of lipohypertrophy also rises. This might be explained by the fact that the growth inducing character of insulin has a multiplying effect on the fat tissue. Previous research has disclosed similar results [7,8]. Diabetes mellitus is a chronic disease. Treatment with insulin must be continued on a life-long basis. There is nothing that can be done for the length of the treatment; we can only control the other factors that have an effect on the development of lipohypertrophy. This study has found that two important controllable factors that influence the development of lipohypertrophy are the frequency of changing injection sites and the frequency of changing needles.

The literature indicates that in diabetics using insulin, not appropriately rotating sites is one of the main instigators of lipohypertrophy [7,15]. In our study, the incidence of lipohypertrophy in patients rotating their injection sites weekly was much lower than in the other groups. However, it was also found that the incidence of lipohypertrophy was high in patients rotating the injection site at each injection and at a percentage similar to those who did not engage in rotation. This finding is indicative of the importance of the form of rotation. If a diabetic uses at least six injection sites (right and left arms, abdomen, legs) and uses each injection site for 1 week, it will be 5 weeks before he/she returns to the same site. During this time the tissue is free from the effect of insulin, which is at the same time a growth hormone. The development of lipohypertrophy is in this way diminished because of the lessening effect of insulin in the area.

All of the diabetic individuals comprising the sampling in this study were given training beforehand about how to rotate an area by using it exclusively for only 1 week. In spite of this, however, a significant portion of the group (41.4%) insisted on either using the same area, selecting an area haphazardly or using a different site at every injection. The reluctance to conform to the training may be explained in various ways. The first factor might be the form of training that was used. Literature indicates that classical diabetic education is not as effective as self-management education using behavioral and psycho-social strategies [16–18]. The individuals comprising the sampling in this research were taught with the classical education model. For this reason, instead of only providing information, we must have faith that training will be more effective if the educator is a good listener, if the patient's needs can be assessed properly and if the patient can be taught how to make his/her own assessment. Another reason the diabetics in the study did not conform to correct rotation habits may be that the injection sites kept on being re-used since there was no pain sensation during the injection in those areas due to the development of lipohypertrophy [1,11,13].

Another factor influencing the development of lipohypertrophy is the frequency of changing needles. In our study, the less frequently the needle was changed, the more frequently seen was the incidence of lipohypertrophy. This result is supported by previous studies [6,8,15]. Needle tips are now minutely cut and siliconed under methods of advanced technology in order to lessen pain and reduce damage to the tissue. The use of the same needle causes damage to the tip of the needle and leads to the loss of the silicone coating, preparing a foundation for tissue damage and subsequent development of lipohypertrophy [6,19–21]. For this reason, it can be said that using the same needle for more than one injection increases the risk of lipohypertrophy.

All of the diabetics comprising the sampling in this study were using insulin pens. In the research studied, it was found that the incidence of lipohypertrophy in pen-users was higher than in those using syringes. The reason the diabetic individuals in the study had a high percentage of lipohypertrophy can be explained by the fact that by using the insulin pen, they were using the same needle more than once. These findings show that the issue of changing the needle on insulin pens frequently should be addressed. Because the healthcare institutions in our country do not provide diabetic patients with a separate needle for each injection, this matter must first be discussed with the health authorities.

Our study showed that education, gender, body mass index and the length of needle did not have an influence on the development of lipohypertrophy. There are examples in literature that however indicate that these factors do in fact affect the development of the condition. At the same time, there are also studies that indicate that the same factors have no effect on the development of lipohypertrophy [2,5–8].

## 5. Conclusions

Our findings strengthen the studies that have been carried out on the subject of lipohypertrophy to date.

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