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Original Article

Injection sites lipohypertrophy among 736 patients with type 2 diabetes of different-grade hospitals

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Abstract: Objective: To investigate the associated factors of lipohypertrophy (LH) in the injection sites among patients with type 2 diabetes of different-grade, hospitals and to improve insulin injection method. Methods: This study was carried out in 10 hospitals, including 4 tertiary hospitals, 3 secondary hospitals, and 3 primary hospitals. A questionnaire was administered, and visual inspection and palpation were performed for diabetes patients with disease duration over 1 year. Methods: Type 2 diabetes patients with disease duration over 1 year from 10 hospitals, including 4 tertiary hospitals, 3 secondary hospitals, and 3 primary hospitals, were questionnaired, inspected and palpated. Results: The incidences of LH in the injection sites of diabetes patients were 58.01% in the tertiary hospitals, 87.08% in the secondary hospitals, and 82.33% in the primary hospitals. The LH in the injection sites was associated with the duration of insulin injection and the injection interval in the tertiary hospitals; the duration of insulin injection and the injection area in the secondary hospitals; and the diabetes duration and the injection interval in the primary hospitals. Conclusions: Educators from different-grade hospitals should take the characteristics of the patients and the factors of LH into consideration to create individualized struction to distribute the standardized insulin injection procedure, as well as to improve the therapy compliance and reduce the patients' economic burden.

Keywords: Diabetes mellitus, insulin, lipohypertrophy, hospital grade

Introduction

Currently, hospitals in China are categorized into three groups: primary, secondary, and tertiary hospitals, according to their scale and function [1]. Of these, the primary hospitals provide disease preventive actions, medical services, health care, and rehabilitation services directly to the communities; the secondary hospitals provide comprehensive medical and health services to multiple communities and undertake partial teaching and scientific research assignments; and the tertiary hospitals provide medical and health services to multiple regions, provinces, and/or the whole nation, and have comprehensive medical care, teaching, and scientific research capabilities [2].

There are approximately 98.4 million people diagnosed with diabetes in China [3], and about 30% of these people receive treatment with subcutaneous insulin injection, which is the main administration method of insulin [4]. The current health education on diabetes is mainly undertaken by tertiary hospitals. In the primary and secondary hospitals, the health education is formalistic, and the content is monotonous, owing largely to a lack of professional nurses and insufficient funding granted by the government. Besides, the patients in the community are generally aged, with long disease duration, and hence do not receive new concepts well, which may undermine the actual effects of health education. At the same time, issues such as incorrect knowledge about insulin injections of the diabetes patients, negligence in terms of rotation of the injection sites [5], reuse of needles [6], and so on, may lead to lipohypertrophy (LH) in the injection cites. In turn, LH leads to poor absorption and sharp glucose fluctuation, which increase the risk of hypoglycemia and aggregate the economical and psychological burdens of the patients and their families.

Methods

Recipients: The study was conducted in 10 hospitals with diabetes nurse clinics from January

Table 1. Demographics and clinical characteristics of diabetes patients

	Total (n=736)	The tertiary hospitals (n=312)	The secondary hospitals (n=209)	The primary hospitals (n=215)	F/χ^2	*P*
Age (year, mean ± SD)	63.79±8.78	62.97±9.45	64.21±8.91	64.35±8.26	2.357	0.095[a]
BP						
SBP (mmHg, mean ± SD)	134.94±18.37	133.24±18.56	135.96±19.69	136.43±16.55	2.374	0.094[a]
DBP (mmHg, mean ± SD)	76.71±10.05	76.69±9.35	76.41±11.68	77.05±9.33	0.213	0.808[a]
BMI (kg/cm^2, mean ± SD)	24.89±3.43	24.59±3.29	25.16±3.96	25.08±3.00	2.195	0.112[a]
Sex (M/F)	329/407	154/158	90/119	85/130	5.287	0.071[b]
DOD (year, mean ± SD)	9.97±6.94	8.60±6.75	11.22±7.16	10.72±6.68	10.985	0.000[a]
HbA1c (%, mean ± SD)	7.70±1.41	7.44±1.21	7.88±1.54	7.91±1.47	9.432	0.000[a]
Incidence of LH (%)	540 (73.37)	181 (58.01)	182 (87.08)	177 (82.33)	66.596	0.000[b]

SD: standard deviation; BP: blood pressure; SBP: systolic blood pressure; DBP: diastolic blood pressure; BMI: body mass index; DOD: duration of diabetes; HbA1c: glycosylated hemoglobin; LH: lipohypertrophy; a: ANOVA analysis of variance; b: Pearson Chi-Square test.

to April, 2015. All investigated patients met the Standards of Medical Care in Diabetes-2013 (i.e. fasting plasma glucose ≥ 7.0 mmol/L and 2-h postprandial blood glucose ≥ 11.1 mmol/L) [7]. Patients were considered eligible if: (1) they had a history of insulin injection >1 year and were aged between 18 and 80 years; (2) had a body mass index (BMI) ≥ 18.5 kg/m^2; (3) various kinds of insulin pens and syringes were used; and (4) the patients were able to complete the questionnaire independently. The exclusion criteria were: (1) patients with a history of mental illness; (2) patients with a history of surgery, injury, skin diseases (such as lupus, psoriasis, etc.), or significant skin defects, or abnormalities (pigment disorders, tattoos, etc.) at the injection sites; (3) a history of insulin use <1 year; (4) patients with a history of diseases associated with shorter survival of the red blood cells (sickle cell anemia, thalassemia, etc.) or that affect the accuracy of the glycosylated hemoglobin (HbA1c) measurements.

Date collection: After providing written informed consent to participate in the study, the patients were instructed to complete the questionnaire for diabetes patients with insulin injections provided by the Chinese Diabetes Society. The studies have been approved by the ethics committee of the first affiliated hospital of Chongqing Medical University (NO.2014-90). This questionnaire includes demographic information and diabetes course, insulin therapy and injections, treatment, and cost.

The presence of LH was examined with the patient in the supine position on the examination bed. The injection site was exposed under natural light, and the pulps of the fingers of the right hand were used to palpate the injection site from the outside inwards, progressively. When an induration or palpable mass was found, the investor marked the boundary and measured the size (in centimeters). The patients demonstrated the process of insulin injections and the process was assessed in regards to whether it was canonical or not.

Statistical analysis

Data was analyzed buy SPSS19.0 software package (SPSS Inc, Chicago, IL, USA). We used ANOVA analysis of variance to analyze patients' age, blood pressure (BP), BMI, duration of diabetes and insulin use, HbA1c, insulin dose, times of inject, per day and frequency of reuse needles. Pearson chi-square test was used to analyze the patients' sex, incidence of LH, regular instructions about insulin injection, reuse rate of needles, rotation of injection site, injection interval less than 1 cm, area of insulin injection, Binary logistic analysis was used to analyze the risk factors of LH. Kruskal-Wallis was used to analyze patients' disease cost which did not obey the normal distribution. Statistical comparisons were considered significant when *p* value of less than 0.05.

Results

General information of diabetics

A total of 736 outpatients treated with insulin injections were investigated, including 312

Table 2. Insulin therapy and injections of diabetes patients with LH

	Total (n=540)	The tertiary hospitals (n=181)	The secondary hospitals (n=182)	The primary hospitals (n=177)	F/χ^2	*P*
Duration of insulin use (yeae, mean ± SD)	4.49±3.92	5.52±4.58	4.59±4.27	5.59±4.88	2.677	0.070[a]
Regular instructions about insulin injection (%)	499 (92.41%)	175 (96.69)	181 (99.45)	143 (80.79)	51.631	0.000[b]
Insulin dose (U/day, mean ± SD)	30.10±15.02	32.27±18.48	29.51±12.59	28.49±13.06	3.072	0.047[a]
Injections/day (n, mean ± SD)	1.94±0.77	2.14±0.88	1.81±0.63	1.84±0.73	10.030	0.000[a]
Time of Reuse needles (n, mean ± SD)	16.56±27.15	14.67±30.11	16.96±25.25	18.07±25.84	0.733	0.481[a]
Reuse rate of needles (%)	513 (95)	166 (91.71)	176 (96.70)	171 (96.61)	6.195	0.045[b]
Rotation of injection sites (%)	511 (94.63%)	175 (96.69)	177 (97.25)	162 (91.53)	7.759	0.021[b]
Injection interval less than 1 cm (%)	452 (83.70)	124 (68.51)	165 (90.66)	163 (92.09)	44.427	0.000[b]

SD: standard deviation; a: ANOVA analysis of variance; b: Pearson Chi-Square test.

Table 3. The area of insulin injection among diabetes patients with LH

	The tertiary hospitals (n=181)	The secondary hospitals (n=182)	The primary hospitals (n=177)	χ^2	*P*
Postcard (15.2 × 10) cm^2	17.68 (32/181)	1.10 (2/182)	7.91 (14/177)	31.12	0.000[a]
Playing card (10.2 × 8.1) cm^2	26.52 (48/181)	19.78 (36/182)	15.82 (28/177)	6.39	0.041[a]
Credit card (8 × 5) cm^2	33.70 (61/181)	58.79 (107/182)	48.02 (85/177)	23.09	0.000[a]
Postage stamp (3.2 × 3) cm^2	22.10 (40/181)	20.33 (37/182)	28.25 (50/177)	3.43	0.180[a]
χ^2		48.31			
P		0.000			

a: Statistical comparisons were considered significant when *P* value of less than 0.0125.

(42.39%), 209 (28.40%), and 215 (29.21%) cases in tertiary, secondary, and primary hospitals, respectively. There were no statistically significant differences in the patients' age, BP, BMI, or gender among the different hospital grades (*P*>0.05). The mean duration of disease was 8.60±6.75 years in the tertiary hospitals, which was significantly lower than the durations in the secondary 11.22±7.16 years and primary hospitals 10.72±6.68 years (*P*<0.05). The mean HbA1c value of patients in the tertiary hospitals was 7.44±1.41%, which was significantly lower than those in the secondary and primary hospitals (7.88±1.54% and 7.91± 1.47%, respectively; *P*<0.05). A total of 540 (73.37%) patients presented with LH in the injection sites, including 181 (58.01%, 181/312) cases in the tertiary hospitals, 182 (87.08%, 182/209) cases in the secondary hospitals, and 177 (82.33%, 177/215) cases in the primary hospitals. The incidence of LH in the tertiary hospitals was significantly lower than those in the secondary and primary hospitals (*P*<0.05) (**Table 1**).

Insulin injection of diabetics with LH

Overall, 92.41% of the patients with LH in the rejection sites received instructions about the insulin injections. However, only 80.79% of the patients in the primary hospitals received instruction about the insulin injections, and this proportion was significantly lower compared to those in the tertiary and secondary hospitals.

The mean daily frequency of injection was higher in the tertiary hospitals than in the secondary and primary hospitals (*P*<0.05). In the LH cases, 97.25% of patients in the secondary hospitals rotated the injection sites, which was a significantly higher than those in the primary and tertiary hospitals (*P*<0.05). 92.09% of patients in the primary hospitals presented with an injection interval of less than 1 cm, which was significantly higher than those in the secondary and tertiary hospitals (*P*<0.05) (**Table 2**).

Injection area of diabetics with LH

The injection areas was defined as large area [postcard-(approximately 15.2 cm × 10 cm)], middle area [playing card-sized (10.2 cm × 10 cm)], small areas [credit card-(8 cm × 5 cm)], mini area [postage stamp-sized (3.2 cm × 3 cm]) in this study. The injection area of the patients with LH from different-grade hospitals

Table 4. Significant factors influencing the LH in diabetes patients

Dependent variables	Independent variables	B	*P*	OR	95% CI
Lipohypertrophy	Duration of diabetes	0.056	0.001	1.058	1.022-1.095
	Rotation of injection sites	2.392	0.026	10.935	1.327-90.092
	Injection interval	-1.629	0.000	0.196	0.127-0.303

OR: odds ratio; CI: confidence interval.

Table 5. Significant factors influencing the LH in different-grade hospitals

Dependent variables	Independent variables	B	*P*	OR	95% CI
Lipohypertrophy of Teritiary hospital	Duration of insulin use	0.085	0.030	1.089	1.008-1.176
	Injection interval	-1.613	0.000	0.199	0.115-0.344
Lipohypertrophy of Secondary hospital	Duration of insulin use	0.192	0.032	1.212	1.017-1.443
	Sizes of injection areas	0.827	0.005	2.287	1.283-4.077
Lipohypertrophy of Primary hsopital	Duration of diabetes	0.082	0.043	1.085	1.003-1.174
	Injection interval	-2.570	0.000	0.077	0.025-0.238

OR: odds ratio; CI: confidence interval.

were difference (χ^2=48.31, *P*<0.001). Large injection areas of the patients with LH were more often observed in the tertiary hospitals than in the primary and secondary hospitals (χ^2=31.12, *P*<0.001). And small injection areas were often observed in the secondary hospitals than tertiary and primary hospitals (χ^2=23.09, *P*<0.001, **Table 3**).

Factors of LH

Moreover, the logistic regression analysis revealed that the incidence of the injection site LH was associated with the duration of diabetes, injection site rotation, and injection interval (**Table 4**). And the incidence of LH at the injection sites was affected by the duration of insulin use and the injection interval in the tertiary hospitals; the duration of insulin use and the injection area in the secondary hospitals; and the duration of diabetes and the injection interval in the primary hospitals (**Table 5**).

Monthly cost of diabetes mellitus

Finally, we found that the insulin cost and the cost for disease of patients with LH was much higher than those without LH. And the cost of insulin in patients with LH from tertiary hospitals was lowest among these different-grade hospitals. The cost of needles was higher than secondary and primary hospitals due to the lowest rate of reuse needles (**Table 6**).

Discussion

At present, there are many diabetes health education modes, the one-to-one mode and lectures are most widely used in the standardization of insulin injection education. But the education method and content is same indifferent-grade hospitals. However, the primary and secondary hospitals are lack of professional nurse of diabetes, so that the diabetes education cannot be adjusted based on the local conditions in these hospitals [8]. And these hospitals often take the form of lecture to save time and manpower cost. Patients can remember insulin injection operation steps roughly through this mode of education, such as rotating the injection site; they are easy to overlook the key details such as injection interval, injection area and disposable needles. Even the insulin sellers provide the guidance of insulin injection to patients in some secondary and primary hospitals. Due to the lack of effect evaluation after class, neither the medical staffs nor patients do not know whether patients get correct self-insulin injection methods.

This survey shows that the incidences of LH in the injection sites of diabetes patients were 58.01%, and the LH was associated with the insulin injection duration and the injection interval in the tertiary hospitals; 87.08% in the secondary hospitals and the risk factors were the insulin injection duration and the injection area; 82.33% in the primary hospitals and the risk factors were the diabetes duration and the injection interval. We also found that the patients with LH in primary hospitals were the oldest and they were reluctant to accept guidance standardization of insulin injection so that the acceptance rate was the lowest. Therefore

Table 6. Comparisons of the medical costs of diabetes treated by insulin injection (RMB)

	LH (n=540)	non-LH (n=196)	Z	P	LH			χ^2	P
					Tertiary hospitals (n=181)	Secondary hospitals (n=182)	Primary hospitals (n=177)		
Insulin cost (mean ± SD)	338.47±228.28	267.74±228.70	-6.128	0.000	323.23±266.37	349.03±227.31	343.20±183.07	14.546	0.001
Drug cost (mean ± SD)	69.38±112.08	66.98±81.57	-1.253	0.210	60.94±95.99	71.25±114.16	76.08±124.57	0.498	0.780
Needle ost (mean ± SD)	19.44±27.10	23.33±27.72	-1.650	0.099	27.63±33.98	16.17±19.13	15.05±25.47	24.636	0.000
Cost for disease (mean ± SD)	429.88±269.33	363.76±254.23	-4.044	0.000	417.18±293.96	436.88±268.49	435.78±243.55	3.541	0.170

SD: standard deviation.

many of them neglected injection site rotation and injection interval. Patients with LH from secondary hospitals reused the needles much more than those from the primary and tertiary hospitals. According to other literatures that the greater the injection area and the lower rate of LH [9]. Patients with LH from tertiary hospitals had a larger injection area than those from primary and secondary hospitals, so the incidence of LH in tertiary hospitals was the lowest. Different hospital should arrange targeted lectures according to the different risk factors and common mistakes.

There are abundant diabetes specialist nurses in tertiary hospitals and the diabetes education clinics have been set up. And they can provide a full-time education [10]. The secondary hospitals' functions positioning are embarrassed, they neither belong to the center of health service system nor belong to the grassroots health service system [11]. These hospitals should create "Professional Specialist and Extensive Integrated Department" brand of service [11]. The secondary and primary hospitals are lack of diabetes specialist nurses, therefore these hospitals should carry out featured diabetes education insulin injection duration and the injection area. And educators should emphasize patients the importance of extending injection area and using disposable needle. To encourage patients to inject insulin standardly, the educators could give patients needles for free if they extend injection area and use a needle only once. After the education the educators should evaluate the effect of the education at the same time.

The patients in primary hospitals are older than other hospitals; they have lower ability of receiving information and poorer memory. Their injection behavior is un-standard, they do not rotate the injection site and the injection interval is less than 1 cm. Nowadays the government wants to build a new-type health service system they increase the investment in primary hospitals [12]. So the primary hospitals can make full use of national resources to popularize knowledge of insulin injection and regulate the insulin injection behavior and deliver the right idea especially change the wrong idea of insulin injection in elderly patients.

The educators could bring plan-do-check-action (PDCA) cycle into their health education practice to discover the problem and solve it in the further education in the different-grade hospitals [13]. And the educators should research and product some pictures, video and formula of insulin injection steps, so that it can be easily understood and remembered by patients.

4/5 diabetic patients are from developing countries [14]. China is still a developing country, the patients are lack of medical knowledge, LH and self-health care consciousness. The insulin needles are not included in the health insurance as well, patients repeated use these needles for saving cost [15]. According this survey, we found that although the patients with LH who use the needles repeatedly so the insulin needles cost was lower than patients without LH who use needles one-time, the total cost for diabetes in patients with LH was much higher than those without LH. Nowadays the diabetes treatment cost has become a major economic burden for low-income people [16], and the disease treatment cost would increase for the unstandard injection behavior. It is urgent to promote the standardization of insulin injection guidance among diabetes patients so that the rate of LH and the economic burden of patients could reduce.

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