Limited Joint Mobility and Plantar Pressure in Type 1 Diabetic Subjects in India

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Abstract

Aim: Limited joint mobility and plantar pressure in the foot has not been assessed in type 1 diabetes. The aim of this study was to investigate the joint mobility and plantar foot pressure in Asian Indian type 1 diabetic subjects and to see its association with duration of diabetes.

Material and Methods: The joint mobility and plantar pressure were measured in 115 consecutive subjects attending the foot clinic. The study groups were: Control - non diabetic controls (n=40) (M:F 19:21) and type 1 diabetic patients (n=75) (M:F 42:33). Joint mobility was assessed using a goniometer at two sites, in the subtalar joint and in the hallux. Plantar pressure was measured using the RS-Scan platform system. Data obtained on the metatarsal heads were used for analysis.

Results: Patients with type 1 diabetes had significantly lesser joint mobility (p<0.0001) and higher plantar pressure (p<0.0001) compared with the control group. Duration of diabetes had an inverse association with joint mobility (p<0.0001). The degree of joint mobility was more restricted in patients with longer duration of diabetes. Plantar pressure increased with increasing duration of diabetes.

Conclusion: In conclusion, type 1 diabetic patients in India had limited joint mobility which decreased further with longer duration of diabetes and they had high plantar pressure also.

Material and Methods

The study was done in consecutive type 1 diabetic subjects seen during a period of 3 months at M.V Hospital for Diabetes which is a speciality hospital attended by diabetic patients of all socio economic strata. The LJM and plantar pressure were measured in 115 subjects; (M:F 61:54, with a mean age of 21 ± 8.2 years).

An age-matched control group of non diabetic subjects were selected from the relatives of the patients was also included. All control subjects were tested with a standard OGTT and diagnosis was made based on the WHO criteria.

The study groups were: Non diabetic control subjects (Control) (n=40, M:F 19:21) and type 1 diabetic subjects (IDDM) (n=75, M:F 42:33). Written informed consent was
obtained from all the subjects and ethics committee of institution approved the study. Age, body weight and duration of diabetes were recorded.

Joint mobility in the foot was assessed at two sites, in the subtalar joint and in the hallux\textsuperscript{11,12}. Subtalar joint mobility was assessed because of its critical role in normal biomechanics of the foot.\textsuperscript{11} With the patient supine and the subtalar joint in the neutral position, a vertical line was marked on the patient's skin from the heel to the midsacral and the maximum range of calcaneal inversion and eversion were measured with goniometer. Range of motion at the metatarsophalangeal joint was measured as follows. With the patient supine and the joint in the neutral position, a line was drawn on the medial aspect of the foot from the tip of the hallux to the heel, and maximal range of dorsiflexion and plantar flexion were determined. The mean of three readings made on each foot was calculated and reported as the mean range of motion at each site. These two sites were selected because of their pivotal role in the biomechanics of normal gait patterns.

The plantar pressure measurement was done using International protocol guidelines.\textsuperscript{13} The mean dynamic foot pressures were measured in patients walking barefoot, using the RS Scan (RS Scan, Belgium) platform system. Data obtained from the metatarsal heads only were used as the 'peak pressure'. All pressures were recorded as N/cm\textsuperscript{2} and then converted to Kpa. The sensor is calibrated using a single limb support model. Based on the subject's body weight, a value based on the force generated in the single limb support is calculated. The various testing parameters are performed after calibration. The patients walked without shoes over the platform, and the maximum plantar peak pressure for the entire foot was obtained. Six dynamic footprints, three from each foot were recorded.

Presence of retinopathy was assessed by indirect ophthalmoscope and slit lamp biomicroscopy. Urine albumin was measured by immunoturbidimetric method\textsuperscript{14} using the reagents from Roche Diagnostics Mannheim, Germany. Urinary creatinine was determined by Jaffe's method.\textsuperscript{15} Albumin/creatinine ratio was calculated and expressed as µg albumin/mg creatinine. A value of <30 was considered to be normal.

**STATISTICAL ANALYSIS**

Data with normal distribution were expressed as mean ± SD. Group comparisons were done by Chi-square or Students ‘t’ test as relevant. A P-value of < 0.05 was considered significant. Statistical analysis was performed using SPSS version 10.0 (SPSS, USA).

**RESULTS**

The clinical characteristics of the study groups are shown in Table 1. As gender differences were absent, data for the total group is shown. Age and mean weight was similar in both the groups.

The degree of inversion, eversion, flexion and extension were significantly reduced in type 1 diabetic subjects when compared with control subjects (P<0.0001). The peak plantar pressure was higher in diabetic patients when compared with control subjects (422 ±114.4 vs 232 ± 90.2, P<0.0001).

**DISCUSSION**

This study was done to determine the joint mobility and
plantar pressure in type 1 diabetic subjects. We found that patients with type 1 diabetes had significantly lesser joint mobility and higher plantar pressures than non-diabetic control subjects. It was noted that LJM decreased and plantar pressure increased with increasing duration of diabetes.

Associations between LJM and microvascular complications have been shown in several cross sectional studies. As reported in the studies from other populations, we found a strong association between LJM and duration of diabetes in our study patients also. Type 1 diabetic patients detected with LJM are potentially at risk of developing foot problems similar to type 2 diabetic patients. LJM and increased plantar pressure appear to be associated with foot ulceration irrespective of duration of diabetes in Indian type 2 diabetic patients. Reduced motion at subtalar and first metatarso-phalangeal joints has been associated with increased plantar pressure.

In a prospective study, elevated plantar pressures were strongly predictive of subsequent ulceration. In fact, ulceration did not occur in subjects with normal foot pressure. The inability to extend the toes fully, found in diabetic adolescents is potentially a more serious problem than in non-diabetic adolescents. Up to 25% of all neuropathic ulcers in adults with diabetes occur as a result of hammer and claw toes being irritated by footwear.

Prevention of future foot disorders is a priority in the management of type 1 diabetes. As LJM affects the soft tissues surrounding the joints, mobilization techniques may prevent some of the pathomechanical changes occurring due to LJM. Longitudinal studies are needed to examine the potential benefits of mobilization on LJM and to ascertain whether these joint limitations persist among type 1 diabetic subjects. In conclusion, type 1 diabetic subjects in India had limited joint mobility and high plantar pressure. An association between LJM and plantar pressure was noted with increasing duration of diabetes.

**References**


