Vibrotactile sense in children and adolescents with type 1 diabetes - signs of subclinical diabetic peripheral neuropathy

MULTI-FREQUENCY VIBROMETRY EXAMINATIONS REVEAL SUBCLINICAL DIABETIC PERIPHERAL NEUROPATHY

Conclusions
- Multi-frequency vibrometry can identify children and adolescents with impaired vibrotactile sense, mirroring diabetic peripheral neuropathy.
- 19% of the subjects showed impaired vibrotactile sense on the foot.
- Impaired sense was more common in subjects treated with multiple daily insulin injections than subjects with continuous subcutaneous insulin infusion.

Introduction
Diabetic peripheral neuropathy (DPN) is a devastating complication to diabetes mellitus, potentially leading to diabetic foot ulcers. Studies using electromyography show a relatively high occurrence of subclinical DPN among children and adolescents, but it is unclear when, and how, to start screening these patients with type 1 diabetes (T1D) for DPN. Most often screening is carried out using tuning fork and monofilaments. However, the sensitivity of both methods is low. The pathogenesis behind DPN is not fully investigated, but good metabolic control has been proved to decrease the severity of the complication.

Aim
To investigate if evaluation of the vibrotactile sense, using multifrequency method, on the hand and foot can be used to detect underlying sensory neuropathy in children and adolescents with T1D, and whether the DPN has any correlation to, for example, gender, age, duration of disease, treatment and metabolic control.

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Abbreviations
CSI = continuous subcutaneous insulin infusion
DPN = diabetic peripheral neuropathy
MDI = multiple daily insulin injections
TID = type 1 diabetes
VPT = vibration perception threshold

CORRELATIONS TO IMPAIRED VIBROTACTILE SENSE
The level of HbA1c did not differ between subjects with normal and impaired vibrotactile sense (A). Children and adolescents with a higher age at disease onset seemed to be more prone to show signs of impaired vibrotactile sense (B). No differences were seen between boys and girls regarding frequency of subjects with impaired vibrotactile sense (C). However, impaired vibrotactile sense was more common among subjects treated with MDI compared to subjects treated with CSI (D).

VIBROGRAMS SHOWING NORMAL AND IMPAIRED VIBROTACTILE SENSE IN CHILDREN AND ADOLESCENTS WITH TYPE 1 DIABETES
The figure to the right shows that impaired vibrotactile sense, mirroring diabetic peripheral neuropathy, is present in children and adolescents with type 1 diabetes. The vibrograms from index and little fingers arise from one 5-year-old girl with normal (black graph) vibrotactile sense, and one age matched girl with impaired (red graph) vibrotactile sense. At metatarsal head 1 and 5 both graphs arise from different 15-year-old boys. The boy represented by the red graph shows general vibrotactile impairment, and the boy represented by the black graph has got normal vibrotactile sense.

Methods
Vibration perception thresholds (VPTs), resulting in curves and numerical values, were evaluated using a VibroSense Meter on the pulp of index and little fingers, and on the sole of the foot at metatarsal heads one and five in T1D patients aged 8-18 years old. VPTs were related to normative data obtained from healthy children, and evaluated in relation to different characteristics. Subjects were also examined with Semmes-Weinstein’s monofilaments tuning perception to light touch. Subjects that failed to produce at least one, out of four, visibly evaluable curve were excluded. Z-values of p<0.05 were considered pathological. Subjects needed at least 3 pathological frequencies at the same site in order to claim that site pathological. Correlations between impaired vibrotactile sense and different characteristics were analyzed using Chi square tests. Differences in characteristics between groups, based on gender and duration, were evaluated using Mann-Whitney U tests.

Results
73 children/days (9% with median age of 12.8 years and median duration of T1D of 5.3 years met the inclusion criteria. Median age at onset of T1D was 7.0 years. Median HbA1c among the subjects was 7.3% (±6 mmol/mol). A total of 45 subjects were treated with continuous subcutaneous insulin infusions (CSI) and 28 subjects were using multiple daily insulin injections (MDI). In total 14 out of 73 (19%) children and adolescents had at least one pathological site on the foot. No children or adolescents presented with impaired perception to light touch. HbA1c values did not differ between subjects with normal and impaired vibrotactile sense (p=0.284). However, subjects with impaired vibrotactile sense had a higher age at disease onset, than subjects with normal sense (p=0.025). No differences regarding impaired vibrotactile sense were seen between boys and girls, but subjects treated with MDI instead of CSI were more likely to present with impaired vibrotactile sense (p=0.007).

No correlations were seen between impaired vibrotactile sense and age or duration of disease.