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Neurophysiological Changes After Implant Placement

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Objectives

The aim of the study was to evaluate the feasibility of a standardized Quantitative Sensory Testing (QST) protocol extra- and intraoral in patients to detect and quantify sensory disturbances of the inferior alveolar nerve due to implantation compared with bone augmentation.
Correct planning before starting therapy using x-ray and adequate measurements should provide a save treatment. Reduction of the alveolar rim may force the operator to work with neurolysis or nerve lateralization which is associated with greater risk for nerve injury.
We intended to investigate whether implant surgery could lead to sensory deficits in trigeminal nerve function depending on the proximity to the inferior alveolar nerve canal even if patients do not report any senso-ry disturbances. Another intention was to determine the degree and dura-tion of possible neuronal hyperexcitability due to local processes three month after treatment and to specify neuronal changes after alveolar nerve injury. QST was used to characterize sensory signs pointing to possible neurobiological mechanisms such as peripheral or central sensitization.

Methods

QST is a non-invasive, psychophysiological approach to evaluate thermal and mechanical somatosensation. The present study applied the protocol implemented by the German Research Network on Neuropathic Pain (DFNS)[1,2] in the orofacial region. Patients who had obtained an implantation in the lower jaw combined with augmentation procedures were examined by implementing a comprehensive QST protocol for intraoral use. Patients were tested bilaterally in the innervation areas of the mental nerve (chin and lip/extraoral and intraoral) and results compared to healthy controls as well as patients being implanted several years ago and patients with a neurological deficit. Thermal and mechanical tests were performed in patients with a radiographically and clinically injured nerve as well as in patients after implantation with no clinical symptoms.

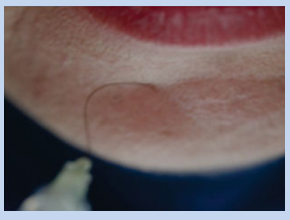


Figure 1: Mechanical Detection Threshold (MDT) was measured with a standardized set of modified von Frey filaments (Optihair2-Set®).

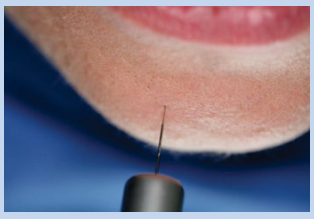


Figure 2: Mechanical Pain Threshold (MPT) was measured using pinprick stimuli .

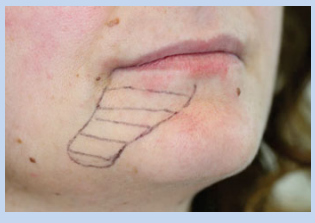


Figure 3: Mapping of the affected area.

The radiological examination showed protrusion of the implant in the alveolar nerve canal in one case treated alio loco. In the other cases proximity to the inferior alveolar canal was evident and x-rays measured using ImageJ®.
Using a prospective human study design, data are presented as mean and statistical comparisons were performed using the Mann-Whitney Test or Spearman Correlation. The analysis was done with JMP® 10.0 statistical software (SAS Institute, Cary, NC, USA)

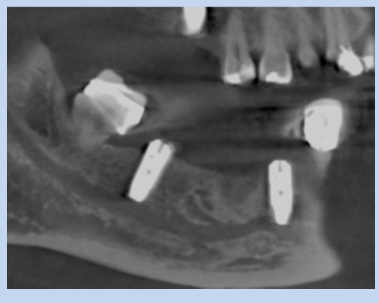
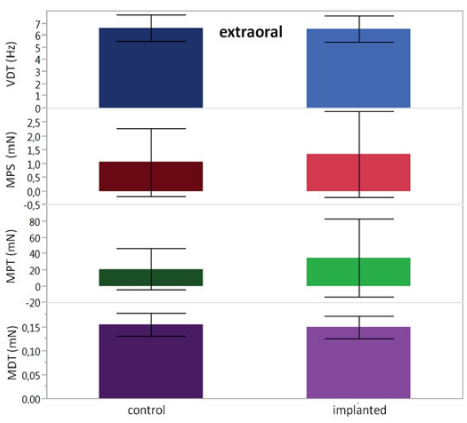
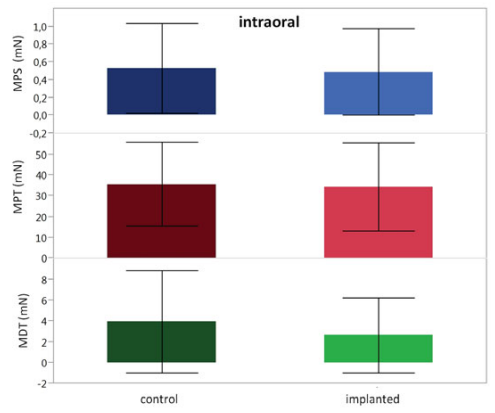


Figure 4: Cone beam CT indicating placement of the mesial implant in the inferior alveolar nerve and the distal one at the roof of the canal.

Results

We evaluated QST parameters between the control side and implanted side in n=12 patients. Equal distribution was seen on both sides. No significant differences not even by trend were measured in all QST parameters. Patients with obvious nerve damage such as shown in figures 1-4 were excluded before.





Confirming QST as an effective evaluation system for patients suffering from nerve injury due to implant placement, we evaluated one affected patient and compared QST values with control sides of n=11 patients. Patient´s (figure 3) affected side compared to all healthy control sides showed increased values for MDT chin and MPS chin as well as reduced values for MPT chin, VDT, PPT chin, MDT lip, and MPS lip. MPT lip was similar to healthy controls. Cold (< 5°) and heat (> 45°) pain thresholds of the affected side were reduced indicating a hyperalgesia. Evaluating the dependency of neurophysiological changes in dependency of the proximity of the implant or implant bed to the inferior alveolar nerve canal, mechanical QST parameters showed no significant correlation in all qualities provided by the inferior alveolar nerve.
No significant neurophysiological changes of the implanted side in dependence on time of reconvalescence after three month were found in all parameters. By trend we evaluated a small reduction of MDT chin over time as well as a slight raising of MPS chin, MPS lip and PTT.

Discussion

The present study applied and partly adapted the QST battery to intraoral sites in order to specify neurophysiological changes after implant placement. Thermal and mechanical tests allowed a determination of the profile and severity of implant related nerve lesions**.** It showed a combined loss of small and large fiber mediated stimuli according to the neuroanatomic pathways with Aβ, Aδ and C-fiber function. Thermal tests showing cold and heat hyperalgesia indicating a peripheral and central sensitization. A slight mechanical allodynia in sense of a hypersensibility for soft touches can point to central sensitization. As a conclusion, reported paresthesia may be a mixture of both neuropathological mechanisms in implant related nerve injury.
By placing implants according to the common guidelines and keeping a small distance (even less than the recommended 1 mm), no significant neurological changes were found. QST showed an obvious correlation between patients´ reported clinical status and small fiber changes intra- and extraorally.The small reduction of MDT chin over time may be related to Aβ-fibers. Because of thick myelinisation exerting a protective effect, MDT is shown to recover more quickly.
In conclusion, monitoring of trigeminal nerve fiber functions by QST intra- and extraoral can describe the profile of impairment and might support decisions on further interventions. The regeneration potential of inferior alveolar nerve seems to be quite enormous if there is not a direct traumatisation.

1 Rolke, R. *et al.* Quantitative sensory testing in the German Research Network on Neuropathic Pain (DFNS): standardized protocol and reference values. *Pain* 123, 231-243, doi:10.1016/j.pain.2006.01.041 (2006).
2 Rolke, R. *et al.* Quantitative sensory testing: a comprehensive protocol for clinical trials. *Eur J Pain* 10, 77-88, doi:10.1016/j.ejpain.2005.02.003 (2006).

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