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Effects of a new piezoelectric device on periosteal microcirculation after subperiosteal preparation

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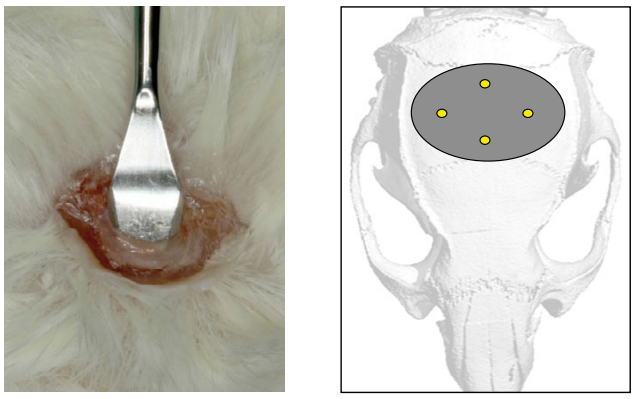
Introduction

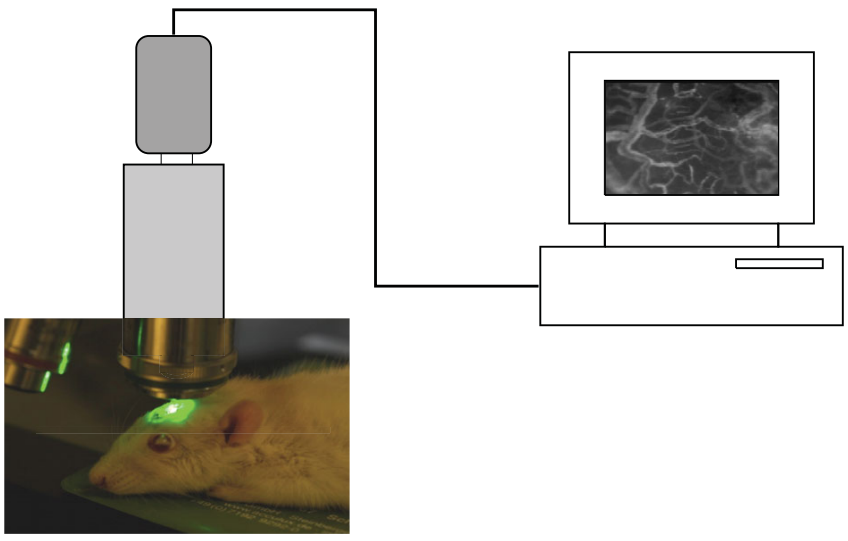
Subperiosteal preparation using a periosteal elevator leads to disturbances of local periosteal microcirculation [1]. Soft-tissue damage can usually be considerably reduced using piezoelectric technology. For this reason, we investigated the effects of a novel piezoelectric device on local periosteal microcirculation and compared this approach with the conventional preparation of the periosteum using a periosteal elevator.



Picture 1: Piezoelectric device for subperiosteal preperation in use on the cranium (left) and periosteal area of intravital microscopy (right)

Material and methods.

A total of 20 Lewis rats were randomly assigned to one of two groups. Subperiosteal preparation on the cranium (picture 1) was performed using either a piezoelectric device or a periosteal elevator. Intravital microscopy (picture 2) was performed immediately after the procedure as well as three and eight days postoperatively [2]. Statistical analysis of microcirculatory parameters was performed offline using analysis of variance (ANOVA) on ranks ($p<0.05$).

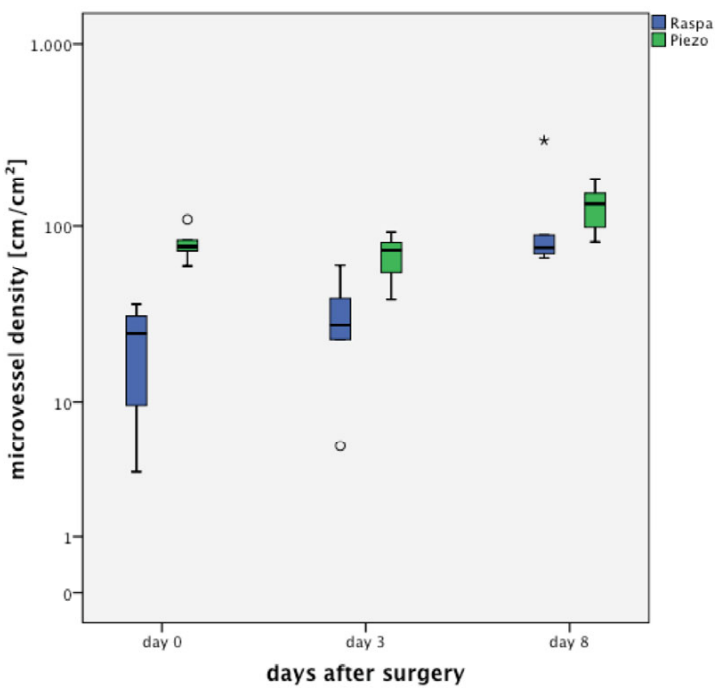


Picture 2: Schematic construction of intravital microscopy

Results

Periosteal microcirculation was imaged in detail using intravital fluorescence microcopy. The group of rats whose periosteum had been prepared with a piezoelectric device was compared with the group of rats whose periosteum had been prepared with a periosteal elevator.

The periosteal elevator group had a significantly lower functional capillary density than the piezoelectric device group at all time points investigated. Postoperatively, both groups showed a considerable increase in functional capillary density, which, however, was always lower in the periosteal elevator group than in the piezoelectric device group (Picture 3). Microvascular red blood cell velocity was significantly lower in the periosteal elevator group than in the piezoelectric device group. During the following 8 days, the red blood cell velocities in the periosteal elevator group became more similar to those measured in the piezoelectric device group.



Picture 3: Microvessel density after subperiosteal preparation; Periosteal elevator (blue) and piezoelectric device (green)

Discussion

Our results show that the use of the piezoelectric device for the preparation of the periosteum was associated with a considerably higher post-procedural periosteal blood flow than the conventional method with a periosteal elevator. Several studies reported that piezosurgery is an atraumatic process that causes only minimal tissue damage. The study presented here confirms this finding for subperiosteal preparation. One possible explanation is that the use of a piezoelectric device leads to the formation of fewer microthrombi during subperiosteal preparation than a periosteal elevator. The results reported here show that the use of a piezoelectric device for the preparation of the periosteum has considerable advantages. Further studies are required to investigate possible positive effects on bone remodeling in patients who have comorbidities and, for example, are treated with bisphophonates, chemotherapeutic agents, or other medications.

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Literature:
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2. Stuehmer C, Schumann P, Bormann KH, Laschke MW, Menger MD, Gellrich NC, Rücker M; A new model for chronic in vivo analysis of the periosteal microcirculation.; Microvasc Res. 2009 Mar;77(2):104-8
3. Gülnahar Y, Hüseyin Köşger H, Tutar Y.; A comparison of piezosurgery and conventional surgery by heat shock protein 70 expression.; Int J Oral Maxillofac Surg. 2013 Apr;42(4)