COMPARATIVE ANALYSIS OF BONE TISSUE TEMPERATURE CHANGES DURING IMPLANT BED PREPARATION USING CONVENTIONAL AND PIEZOSURGICAL METHODS IN DENTAL IMPLANTOLOGY

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Objective: *The aim of this study was to assess the risk of thermal damage to bone tissue during implant bed preparation using conventional mechanical (rotational) and piezosurgical methods, and to develop recommendations for preventing thermal injury during osteotomy.*

Materials and Methods:

The laboratory study included a human cadaveric mandible and an animal mandible (sheep) with preserved soft tissues. Implant bed preparation was performed using two methods:

1) Standard rotational method using an Implantmed physiodispenser (Austria) and AstraTech drills (Sweden) according to the clinical protocol;

2) Piezosurgical method using the Implant Center device (France) and Bone Surgery II tips (France).

To simulate different clinical scenarios, irrigation modes and operational parameters of the instruments were varied.

Experimental conditions included:

• Rotational drill: diameter 2.0 × 11 mm, rotation speed 35,000 rpm.

• Irrigation modes: no irrigation, minimal irrigation, and maximal (adequate) saline irrigation.

• Piezo tip No. 1, power D1, irrigation modes: minimal and maximal.

• Irrigation solution: 0.9% NaCl at room temperature (23°C).

• Initial temperatures: human bone — 18.3°C; animal bone — 14.3°C.

• Thermometry was performed using a Fluke 51II thermocouple thermometer (USA), with measurements taken at osteotomy sites and adjacent bone areas. Cutting time was monitored using a digital stopwatch.

Each experimental condition included a series of repetitions (at least 5 measurements), recording maximum and average temperature increases during continuous instrument operation (5 s for rotational drills and 30 s for piezo devices), as well as cooling dynamics after cessation of cutting.

Results:

Thermometric results demonstrated that bone temperature increase depends on the preparation method, irrigation presence and intensity, and duration of continuous instrument operation.

1. Rotational Method:

• Continuous drilling for 5 seconds with minimal irrigation resulted in a maximum temperature increase up to 27°C.

• Without irrigation, temperature in the osteotomy zone increased to an average of ~33°C (±3°C), exceeding levels associated with thermal injury risk.

• With maximal irrigation, temperatures were maintained within 16–22°C, significantly below thresholds for thermal necrosis.

2. Piezosurgical Method:

• With minimal irrigation, 30 seconds of operation led to temperature increases up to 31°C.

• With maximal irrigation, temperature reached up to 27°C, remaining within safe limits.

Conclusions:

1. Irrigation is a key factor in preventing thermal necrosis during implant bed preparation in both methods.

2. Absence or insufficiency of irrigation significantly increases bone temperature and the risk of thermal injury.

Scientific Rationale:

These findings are consistent with classical and modern studies on thermal thresholds in bone tissue. Eriksson and Albrektsson (1983) demonstrated that exposure to 47°C for one minute causes irreversible osteonecrosis. Matthews and Hirsch (1972) highlighted the importance of irrigation in reducing thermal effects during bone cutting. Piezosurgical techniques (Vercellotti et al.) offer precision advantages but may also lead to overheating without adequate cooling.

Practical Recommendations:

1. Ensure adequate irrigation with 0.9% NaCl solution.

2. Use intermittent cutting режим for rotational drills.

3. Monitor temperature and irrigation during prolonged piezosurgical procedures.

4. Optimize technique and instrument selection to minimize heat generation.

Study Limitations:

Laboratory conditions using cadaveric and animal specimens may not fully reflect clinical conditions of living bone with blood supply and metabolism. However, the model allows for comparative analysis of thermal risks.