Abstract

Objectives:
1. Highlight differences in temperature variations achieved by common otomicroscopes.
2. Appreciate that thermal injuries are possible during otologic surgery with the advent of newer, high-powered otomicroscopes.

Methods: A variety of otomicroscopes, with different light sources (ranging from 100W halogen to 300W xenon), were studied. Temperatures were recorded from human tissue (hand). Ambient temperatures were also noted. A control recording was also done on a stainless steel ear speculum. Recordings were done at five minute intervals until maximum temperature stabilized. A working distance of 225mm was maintained and light intensity was kept at 100% during all recordings.

Results: Maximum skin temperatures were found to plateau relatively quickly, with higher wattage xenon light sources reaching higher temperatures. The highest temperature obtained was 43.3°C by a Zeiss Pentero (Carl Zeiss, Germany). One way ANOVA revealed significant differences in temperatures between the five microscopes [F (4, 72) = 15.31, p < 0.05]. Post-hoc analysis revealed that the Zeiss Pentero had significantly higher average temperatures compared to three other microscopes used. Speculum recordings did not have higher temperatures.

Conclusions: There is substantial variation in maximal temperatures reached by the operative microscopes. Second degree skin burns have been described with prolonged exposures to temperatures greater than 44°C. This high temperature was approached in the current study by a single microscope at 100% light intensity. Given the described potential for burns, surgeons operating on the ear and temporal bone should take precautions to diminish temperature in the operative field.

Methods and Materials

This study was classified as exempt by the SUNY Upstate IRB.

Characteristics of the microscopes used in this study are noted below:
- Zeiss OPMI 1-FC; 100 W halogen bulb
- Zeiss OPMI Moven; 180 W xenon bulb
- Zeiss OPMI Pentero; 300 W xenon bulb
- Zeiss OPMI NC-4; 300 W xenon bulb
- Zeiss OPMI NC-31; 300 W xenon bulb

A General™ IRT207 Infrared thermometer (pictured below) was used for recordings. The ambient temperature of each room was recorded during the testing as well. The microscopes were tested on 100% light intensity at a working distance of 225 mm which was measured prior to each recording and maintained throughout. The light was directed to the center of a hand (TI) for tissue recordings. One control recording was also done with a stainless steel ear speculum. Recordings were done at five minute intervals until maximum temperature stabilized. Two recordings were done for each microscope to ensure consistency. One way ANOVA was used to compare the temperatures between the different microscopes. All temperatures were recorded in degrees Celsius.

![Photo of thermometer utilized during recordings.](image)

![Average microscope temperature recordings as plotted against time.](image)

Table 1. Microscope temperature characteristics and average time to plateau. *Asterisk denotes significant difference.

<table>
<thead>
<tr>
<th>Microscope</th>
<th>Max Temp (°C)</th>
<th>Avg. Temp (°C)</th>
<th>Plateau (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-FC</td>
<td>34.0</td>
<td>32.1</td>
<td>15</td>
</tr>
<tr>
<td>Moven</td>
<td>38.0</td>
<td>32.9</td>
<td>20</td>
</tr>
<tr>
<td>Pentero</td>
<td>43.3</td>
<td>38.5*</td>
<td>15</td>
</tr>
<tr>
<td>NC-4</td>
<td>35.7</td>
<td>32.6</td>
<td>20</td>
</tr>
<tr>
<td>NC-31</td>
<td>39.5</td>
<td>37.0</td>
<td>25</td>
</tr>
</tbody>
</table>

References

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Discussion

Maximum temperatures were found to plateau relatively quickly. The highest temperature obtained, 43.3°C with the Pentero, can result in pain responses and could even be capable of second degree burns with prolonged exposure.

Thermal injuries depend on many factors, including patient characteristics of skin thickness and resistance, microscope properties, and surgical factors such as exposure time, working distance, draping, and use of irrigation. 300 W xenon lighting systems are more widely utilized and are capable of achieving much higher temperatures compared to halogen systems, thus microsurgeons needs to be cognizant of the potential for injury.

This pilot study was limited in that only one individuals skin was tested, and other factors were not assessed in this controlled setting. We also relied on a readily available commercial infrared thermometer which may not have the same degree of reliability as other industrial systems. Temperatures obtained in this study may be underestimated given the short time of recordings; more gradual, higher temperature plateaus could feasibly be reached with recordings on the duration of hours, as is typical for many otologic procedures.

Conclusions

Operating microscopes are capable of quickly reaching temperatures that can result in pain and thermal injury with long exposures. Surgeons need to be cognizant of factors that can predispose patients to thermal injury.