

## *Heat study*

### **Milestone-**

The heat study is being performed under the direction and control of a Top-5 Global Dental Product OEM and top tier education facility. The study will compare the associated temperature rise in the interior sections of the tooth during processes associated with traditional cavity restoration. To accomplish this, thermocouples are embedded in extracted molars and sealed these with a non-heat conductive material from the underside of the tooth. A certain quantity of these modified molars will be provided to Dentavations along with a data logger. Dentavations will mount these, one at a time, to the test fixture that has been used in previous testing and conduct cutting on the tooth that simulates the use of the Waterjet cutting system during a normal cavity restoration by a dental professional. The information collected by the data logger will then be forwarded for comparison to results being compiled on traditional restoration approaches.

### **Thesis-**

There is a known direct correlation between temperature rise during dental procedures and pain. The elimination or non-generation of heat should therefore negate most pain. In collaboration with industry partners it was determined that measuring if heat is generated by the WaterJet that it would be a good indicator of pain-free dentistry.

### **Background-**

Dental professionals and the management team associated with the validation of this milestone compiled a list of relevant scientific articles to determine the best approach to conducting the heat study. If the WaterJet raises the temperature of a tooth during a procedure, then a traditional drill will also be tested. This review helped to establish the guidelines and objectives of the Heat study.

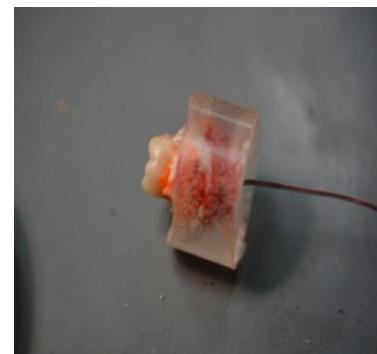
All materials, including Probes, a data logger and heat paste were then procured and provided to Dentavations to conduct the milestone validation.

The link to the data logger is: <https://www.omega.com/en-us/control-and-monitoring-devices/data-logger/om-el-usb-tc-series/p/OM-EL-USB-TC>

The thermocouples are type T. You can look up their info on Omega's website with item number 5SC-TT-T-30-36.

The conductive paste is Item# OT-201-2.

Extracted human molars were obtained and prepped for the thermocouples. It was determined that placing the teeth in heat paste and then mounting in acrylic with the probe in the root was the best method to conduct the study.



### **Procedure-**

Attached with this email are detailed reports of each data point obtained during cutting of the tooth with the test fixture. Five heat study sample were run. These tests were done at the exact settings the current prototype system runs to accurately represent real world use of the system. However, all tests were performed using the test fixture to allow for repeatability and consistency tooth to tooth. Each tooth was removed from the mold, the roots were packed with thermo paste, then the probe was inserted into the root that it would reach the furthest up. Care

was taken to remove tooth as close to the probe as we could to further represent the most accurate form of testing to real world experience for the most accurate readings. We ran tests with two different pumps and at a wide range of pressures starting at 750 and ending at 1250. Different pressure setting were used to determine if higher pressure usage, resulting in faster tooth removal could cause differing temperature results but none were determine. The first two tests show similar results, on the third test (iota 750 330.5start) I cut into the pulp chamber of the tooth and that coincides with the lower temps. The last two samples were done at higher pressures with a different pump. Only the cut times are in the files. These tests were run in our shop which is about 60 degrees. All the teeth samples and fluids used were stored together for several days prior to testing. Therefore, the base temperature of both teeth and cutting slurry were in the low 60 degree range.

## Results-

These results show that using the WaterJet does not increase heat in the tooth. Another point worth noting is that we aren't generating heat during the procedure and therefore shouldn't have a Heat Affected Zone like the traditional drill. We can always warm the slurry to avoid cold sensitivity. You also see that each test has a higher starting temp than the previous test on the same day. We attribute this to the sensor and pump warming up with use.

A synopsis of the tests is below:

	Start temp	End Temp	Elapsed Time	Pressure
Friday				
iota 750, start 241	57*	57.5*	114 seconds	750 PSI
iota 750 259.5 start	58.5*	58.5*	126 seconds	750 PSI
iota 750 330.5start	63.5*	61*	163 seconds	750 PSI
Monday				
1000paint start1056	61*	60.5*	171 seconds	1000 PSI
1250 paint 1113start	64*	63.5*	84 seconds	1250 PSI



Representative cut that was performed