Thermal Cycling: Can it Extend Tool Life in Orthopaedic Operating Rooms?

Introduction: Thermal Cycling is a proprietary patented temperature modulation process developed to improve the performance, strength and longevity of a variety of materials. It has been used with great success in the automotive, aeronautic and manufacturing industries. Surgical instruments such as drill bits undergo cyclical loading and generally fail by dulling, suggesting that thermal cycling may improve their performance and longevity.

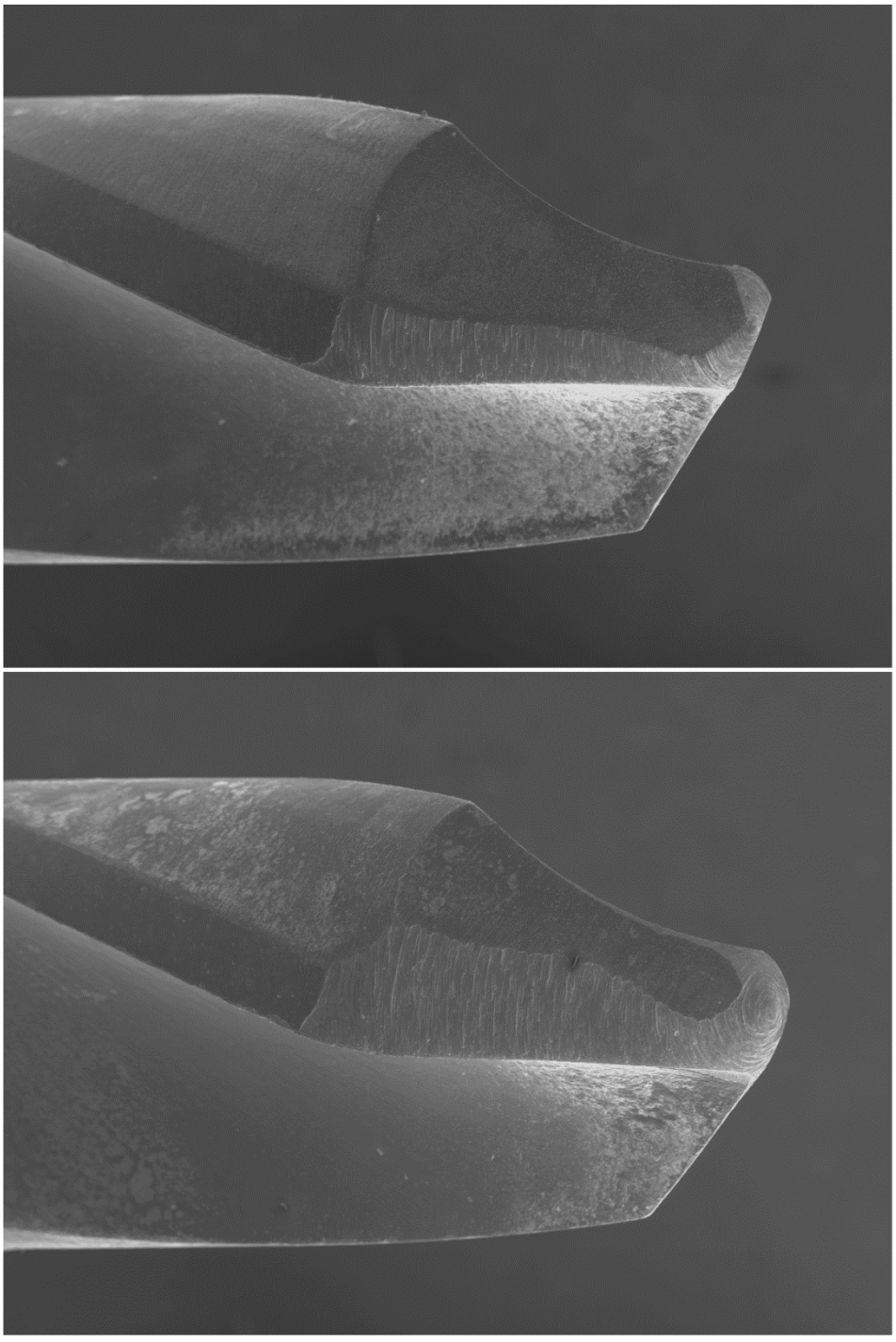
Hypothesis: Thermal Cycling will improve wear properties and longevity of surgical drill bits under cyclic loading in bone tissue.

Methods: Ten 2.5 mm drill bits were randomized and maintained in a blinded fashion, and five of these specimens underwent Thermal Cycling. Using an in-house manufactured testing jig which allows attachment of a surgical drill directly to an MTS Bionix 858 servohydraulic testing machine, 100 drilling cycles were performed at a constant displacement rate into the diaphyseal region of bovine femurs with each trill bit. After every 25 cycles, data was collected by performing identical drilling cycles into a cortical bone simulator. The maximum force, maximum normalized torque and work required to maintain this displacement rate was measured, representing the degree of wear on the drill bit. Furthermore, a Scanning Electron Microscope was used to measure the flank wear on each drill bits. Student t-tests were used to compare the cycled drill bits to the controls.

Results: After 100 drilling cycles, the maximum drilling force required by the thermally cycled drill bits was 62.5 ± 9.6 N, compared to 76.8 ± 3.1 N in the control group ($p=0.0153$). The maximum normalized torque was 17.3% ± 1.8% in the thermally cycled group, compared to 24.9% ± 5.6% in the control group ($p=0.0368$). The work required to drill with the thermally cycled bits was 439 ± 78 J, compared to 574 ± 18 J in the control group ($p<0.01$). The microscopic flank wear on the cycled drill bits was 429 ± 63 μm, compared to 559 ± 18 μm in the control group.

Conclusions: The thermally cycled drill bits have drilling performances significantly superior to that of standard drill bits, with respect to work, maximum force and torque. The data demonstrates that the thermally cycled drill bits wear at less than half the rate of standard drill

bits. This finding has the potential to decrease surgical time and frustration, as well as significantly reducing thermal necrosis. Furthermore, if this technology is applied to other surgical cutting tools such as saw blades and reamers, it may result in significant savings to operating room budgets.



The image on top is a cycled drill bit, while the image below is a non-cycled drill bit. In the graphs below, the orange data points represent the cycled drill bits, while the blue data points represent non-cycled drill bits.