A New Variable Depth Control Drill That Provides Real Time Depth Control And Prevents Drill Bit Plunging Associated With Standard Medical Drills.

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Background/Purpose: Plunging past the far cortex when drilling bone is unavoidable with present handheld drill technology. Attempts at reducing the plunge with static mechanical drill stops have limited applications in the myriad of environments and drilling depths surgeons encounter. The Variable Depth Control (VDC) device, a new handheld robotic drilling technology, provides real time depth control while drilling and essentially eliminates the inadvertent "plunge" past the far cortex. VDC technology also provides real time depth measurement integrally related to its depth control.

Methods: Soft tissue plunge models were created using bi-cortical surrogate bone blocks placed upon standard FBI Ballistic Gels (Sawbones part numbers 1522-1132 and 1522-1135, Pacific Research Laboratories, Vashon, WA). The bone models ranged in nominal depth from 15 to 27 mm and were randomized. Sharp 3.2 mm drill bits were utilized for all 100 trials.

Five orthopaedic surgeons of varied clinical experience were introduced to the VDC device and allowed to perform 3-5 test holes to familiarize themselves with the new device. Each surgeon then completed 10 drill trials with a Standard drill and 10 drill trials with a VDC drill. The soft tissue plunge was measured and recorded for each trial. The data were analyzed using StatPlus:mac software.

Results: The average plunge depth with the Standard drill technique was 8.4 mm. The average plunge depth using the new VDC technology was significantly less at 0.5 mm (t-test, $p<.001$), see Figure 1. The plunge was essentially eliminated with the new VDC technology.

Conclusion: In 100 drill trials, the use of the new Variable Depth Control (VDC) technology by five orthopaedic surgeons statistically reduced the inadvertent plunge past the far cortex when compared to a standard handheld drill in a synthetic bi-cortical bone model (see Figure 2). The inherent plunge associated with present handheld drilling techniques is a product of multiple factors including human reaction time (140-180 msec, see Figure 3). Despite very fast human reaction times, plunging studies report the typical plunge depth to be 10-16 mm for even the most experienced of orthopaedic surgeons. These inevitable plunging events place vital structures at risk. VDC technology eliminates the plunge and may provide a significant reduction in these plunging events during orthopaedic surgery. Future VDC studies with cadaveric bone are planned followed by human clinical trials.

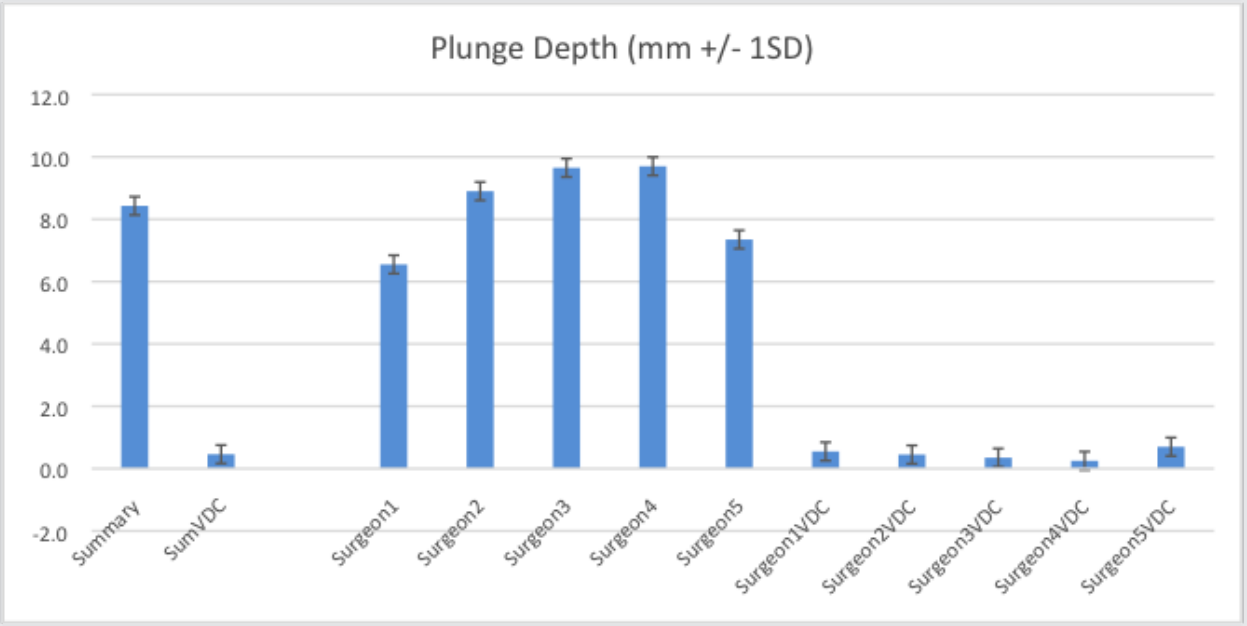

Figure 1. Difference in plunge depth for 5 surgeons, each performing 10 Standard drill trials and 10 VDC drill trials.

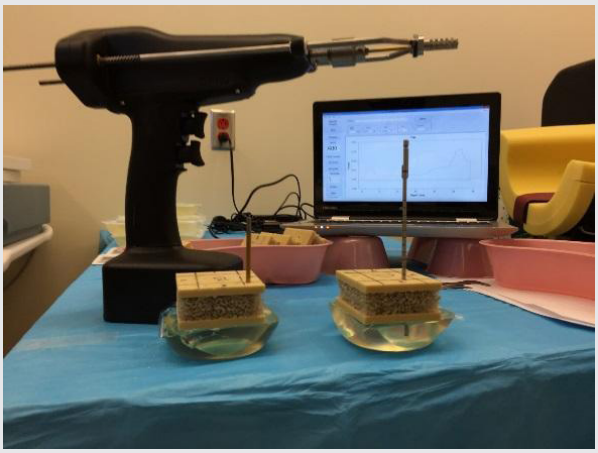

Figure 2. Plunge models showing essentially no plunge with VDC drill on left; plunge model to right with Standard drill and 10 mm plunge.

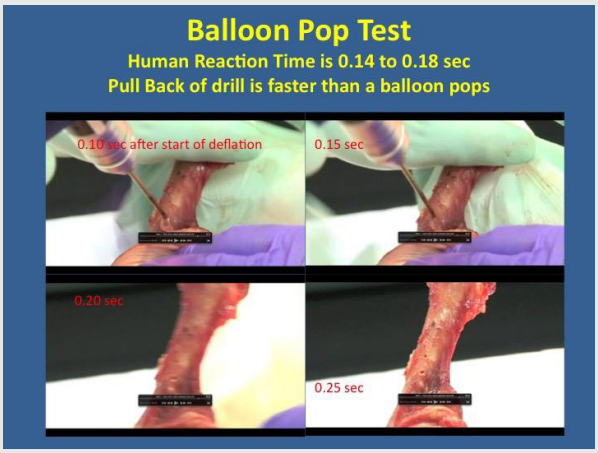

Figure 3. Balloon pop test shows drill pullback is faster than the blink of an eye (300 msec) or pop of a balloon (150 msec). But plunge is still 10-16 mm on average.