Comparison of Heat Dissemination from Longitudinal and Torsional Mode Ultrasonic Shears using Infrared Thermal Imaging and Thermocouples

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Background & Aims

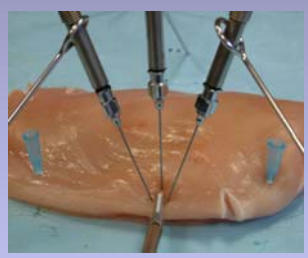
Ultrasonic shears generate heat at the interface between waveguide and tissue that is necessary for coagulation and cutting.

This study compared waveguide and tissue temperatures generated by shears that operated on longitudinal (Harmonic Scalpel®, 55.5 kHz, Ethicon Endo-Surgery) and torsional (LOTUS™, 36 kHz, SRA Developments Ltd.) vibration modes.

Methods

An infrared digital camera (FLIR Systems) was employed to capture thermographic images and video clips of both devices cutting into bovine muscle tissue and then allowed to cool. Recorded images were reviewed and analysed using supplied softwares.

Three thermocouples in 0.8 mm diameter needles (Pico Technology) were positioned in chicken muscle tissues near each blade to measure lateral thermal spread during and after cutting.

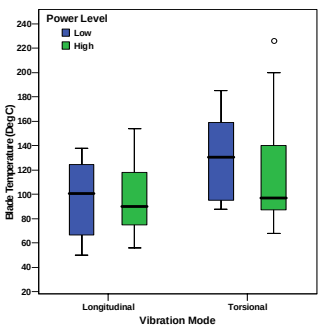


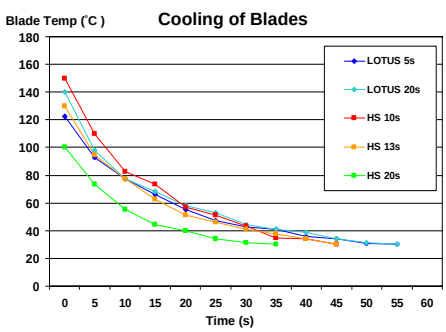
Blade Temperatures

Torsional mode shears generated more heat than longitudinal mode shears, but the difference was not significant (p = 0.079).

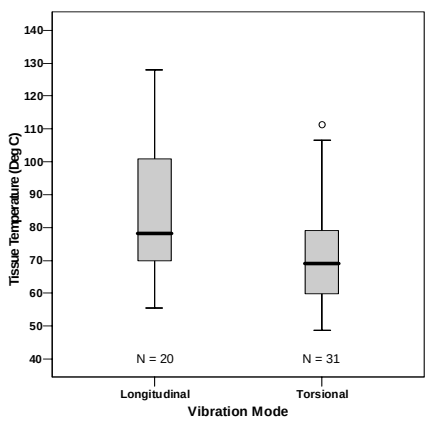
For both devices, blade temperature was not influenced by number of cuts made in succession or power settings.

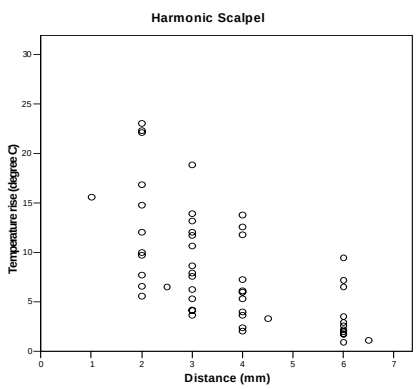
In room air (21 ˚C), both blades took about 25 s to cool to 50 ˚C and a further 20 s to 33 ˚C.

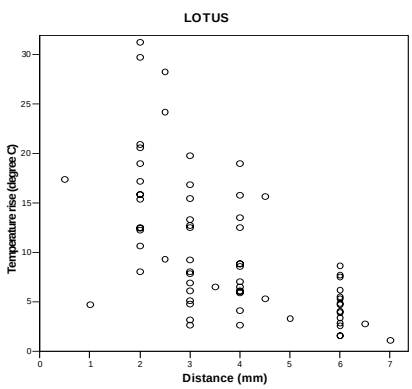




Tissue Temperatures







Median tissue temperature at the cut edges immediately after cutting was 78 (55-128) ˚C with Harmonic Scalpel and 69 (48-111) ˚C with LOTUS (p = 0.023).

Device	Harmonic Scalpel	LOTUS	*p* value
Thermocouples distance (mm)			
Mean	3.70	3.75	0.843
Range	1.0-6.5	0.5-7.0	
Temperature rise (˚C)			
Mean	8.27	10.17	0.150
Range	0.96-23.08	1.16-31.37	

Conclusions

Despite differences in vibration mode, frequency and blade design of both devices, the heating and cooling characteristics of both blades were similar.

However, tissue temperature was higher at the cut surface with longitudinal mode shears because heat production was mainly by frictional force of the blade against the tissue. In contrast, the torsional mode device transfers energy by a more direct compressional force into the tissue.

Both shears produced similar amount of lateral thermal spread in tissues during dissection.