Radiofrequency Neurotomy Does Not Cause Heating in Nearby Implant Materials

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Statement of Purpose: Chronic neck and lower back pain is often attributed to facet joints. A common and effective treatment of facet joint pain is radiofrequency (RF) neurotomy or rhizotomy. Some patients undergoing RF neurotomy have had previous surgeries that require implantation of hardware. The primary objective of this study is to determine if harmful heating occurs in titanium alloy (Ti-6Al-4V) and 316L stainless steel implants when the RF neurotomy procedure is performed in proximity of these implants. A secondary objective is to determine whether the presence of these materials can affect the impedance measured between the RF probe and return electrode.

Methods: Five 6 mm diameter, 25.4 mm long Ti-6Al-4V rods and five 316L stainless steel rods of the same dimensions had a 1.4-mm diameter hole drilled to the geometric center of each sample. A grounding pad (Smith & Nephew, Inc., Andover, MA) was placed on one side of a lean beef specimen and an RF probe (Smith & Nephew, Inc., Andover, MA) was inserted into the approximate center of the beef specimen through an RF cannula (Smith & Nephew, Inc., Andover, MA). This experimental setup was placed in a temperature controlled oven (Tenney Environmental, New Columbia, PA) and allowed to equilibrate to 37±1 °C. Equilibrium temperature was confirmed by readings from an internal type-T thermocouple on the RF probe. The impedance between the grounding pad and RF probe was measured. A Ti-6Al-4V sample was completely inserted between the grounding pad and the RF probe at a distance of 20 mm from the RF probe. The impedance was again measured. The difference between the impedance before and after was recorded and attributed to the presence of the implant. A type-T thermocouple coated with thermal couplant was inserted into the Ti-6Al-4V sample. A treatment was delivered from the ET20S generator (Smith&Nephew, Inc., Andover, MA) with a maximum temperature setting of 90 °C and treatment duration of 120 seconds. The RF probe was moved to a distance of 10 mm from the sample and the temperature was allowed to equilibrate to 37±1 °C. The treatment and measurements were repeated. This process was repeated with the RF probe moved to 5 mm from the implant material. To determine heating due to the RF probe without the presence of the implant material, a grounding pad was placed on one side of a lean beef specimen. An RF probe was inserted into the approximate center of the beef sample through an RF cannula. Type-T thermocouples were inserted at 5, 10, and 20 mm from the RF probe between the RF probe and the grounding pad. The setup was allowed to equilibrate to 37±1 °C as confirmed by readings from both the denervation probe and the thermocouple. A treatment identical to the one for the previous experiment was delivered from the ET20S generator. This process was repeated in four additional beef specimens. The heating due to the presence of the metal sample was the temperature difference between the average maximum reached in the absence of the implant and the maximum temperature in the presence of the implant.

Results/Discussion: Figure 1 shows the average maximum temperature achieved in the Ti-6V-4Al, SS-316L, and control samples at distances of 5, 10, and 20 mm from the RF probe. An unpaired, two-tailed t-test revealed no statistically difference between the average maximum temperatures of each material and the control at each distance. Therefore, the presence of the implant material did not cause any statistically significant difference in the heating of the tissue during the RF neurotomy.

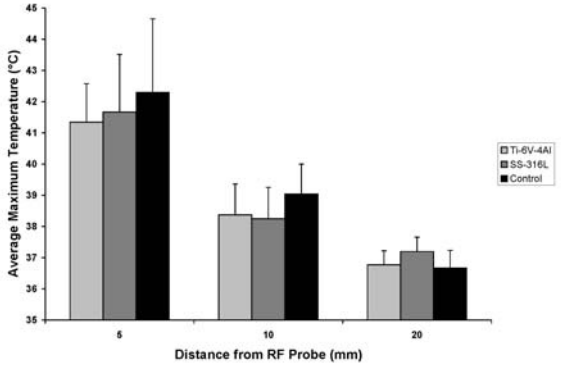

Figure 1. Average maximum temperatures reached inside the Ti-6V-4Al, SS-316L, and control (beef sample with no implant material) at distances of 5, 10, and 20 mm from the RF probe.

Table 1 shows the average difference in the impedance measured with and without the implant materials. There was only a small increase (~3 Ω) in impedance due to the presence of the implant materials. This is between 1.5 and 3.0% of the expected range of impedances (100-200 Ω).

Table 1. Average impedance difference with and without implant materials at different distances from the RF probe

	Average Impedance Difference		
	5 mm	*10 mm*	*20 mm*
Ti-6V-4Al	3.2 ± 0.8 Ω	2.0 ± 1.0 Ω	2.8 ± 0.8 Ω
SS-316L	2.6 ± 0.9 Ω	3.3 ± 1.1 Ω	2.3 ± 0.5 Ω

Conclusions: There was no statistical difference in the maximum temperature reached during RF neurotomy with or without the presence of Ti-6V-4Al and 316L stainless steel implants. There was a small increase (~3 Ω) in impedance readings due to the presence of the implant materials.