Effect of various storage methods on the dielectric properties of compact bone

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Abstract—In the study the effects of various storage environments on the dielectric properties of bone were evaluated. Fresh cortical bone specimens from canine femora and tibiae were prepared and divided into three groups, with one group maintained at room temperature (24°C), a second group stored in a refrigerator at 3°C, and a third group stored in a freezer at −10° to −20°C. In each group, both the resistance and the capacitance decreased with time, the percentage change being largest for the samples stored in the freezer. This suggests that storage of bone specimens in a refrigerator or freezer with repeated thawing at room temperature does affect the dielectric properties of bone, the effect being dependent on the method of storage.

Keywords—Bone, Bone impedance, Capacitance, Dielectric properties, Electrical properties, Resistance, Storage medium

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were tested similarly, measuring only the resistance values. intervals up to 5 days were taken on these 11 bone compact bone specimens, respectively, all samples being groups were composed of four, three and four machined readings on these bone samples. However, to verify our samples. Most of our results and analysis are based on the results, four additional bone samples from a second dog stored in a freezer at -10 ~ to -20~ The next day the bone specimens were removed from their environment and returned being the same on all four days. The procedure throughout the day. At the end of the first day, the samples were divided into three groups. The first group was maintained at room temperature (24°C); the second group was stored in a refrigerator at 3°C; and the third group was stored in a freezer at -10~ to -20°C. The next day the bone samples from the second and third groups were removed from their storage environments and allowed to thaw and equilibrate to room temperature. Then the resistance and capacitance of all specimens were measured repeatedly through the course of the day. The procedure was repeated for up to four days, with the times at which the bone specimens were removed from their environment and returned being the same on all four days.

Initially the room temperature, refrigerator and freezer groups were composed of four, three and four machined compact bone specimens, respectively, all samples being from the same dog. Repeated readings at different time intervals up to 5 days were taken on these 11 bone samples. Most of our results and analysis are based on the readings on these bone samples. However, to verify our results, four additional bone samples from a second dog were tested similarly, measuring only the resistance values.

These four specimens were maintained at room temperature only throughout the 100h observation period. Table 1 shows the total number of bone samples tested in each group and the exact times of measurements throughout the five day observation period.

The electrical properties were measured using chlorided silver metal electrodes in the setup shown in Fig. 2. Surface moisture was removed from the bone prior to measurement, and a layer of conductive gel (Aquasonic 100, Parker Lab.) was applied to the bone surfaces and to the electrodes. All measurements were made in the axial direction only. Because of the effect of exposure time (SAHA et al., 1984), the amount of time between the removal of the sample from the solution and the measurement was kept constant for each measurement.

3 Results

Fig. 3 shows the normalised resistance against time for the three groups of bone specimens maintained in three storage environments for each of the five days. The values for each day were calculated as the mean for the hourly readings for that day. For day 1, no significant difference in the specific resistance was found among the groups (p > 0.05). For days 2-4 there was also no statistically significant difference between the room temperature and refrigerator groups, but there was a significant difference between the freezer and the room temperature or refrigerator groups (p < 0.01). There was also a significant difference between the freezer and the room or refrigerator samples for day 5 (p < 0.05). The resistance for the group stored at room temperature showed no significant decrease (p > 0.01) until day 5, yet this group had a larger variance than the other groups. The group stored in the refrigerator showed a significant decrease (p < 0.05) only for days 3 and 4. The third group, that was stored in the freezer, showed a significant decrease (p < 0.01) for each day except for day 5. The resistance of one sample at room temperature began to increase at day 5, whereas that of the other specimens continued to decrease, this being the reason for the large standard deviation noted. The reason for this increase is still unknown.

From Fig. 3, it appears that the change in resistivity was minimum for the specimens stored at room temperature; thus this may be the preferable mode of storage. To obtain increased confidence in the measured data on the resistance of the room temperature group, four additional compact bone specimens from another canine femur were tested as described before. The change in normalised resistance for all eight bone specimens Table 1 as a function