Review of Literature

Overview of Dentin

The subject that we used for our experiment is a sample of elephant dentin.  A tooth is a very dense material which is made up of material different substances.  Coating the outside of tooth is enamel, the hardest tissue produced by the human body.  The function of enamel is to provide protection to the tooth.  Just inside the enamel is dentin or dentine.  Dentin is not as solid or as hard as enamel, but it is in much greater quantities than that of enamel.  Dentin extends all the way down to the base of the tooth, making up a large portion of the tooth.  Dentin is very similar to human bone, except stronger.  Inside dentin is pulp, a much softer substance consisting of fibers, blood vessels, and nerves that respond with toothache to damage to pulp or dentin.

*Picture of a human tooth*

Pulp also provides nutrition to the dentin, but a fully developed tooth can survive with the pulp being removed.  At the base of the tooth is a layer of cementum, a hard substance which holds the root in place and cushions the tooth against the gum from grinding.

However, in our experiment we will be using just dentin, the substance on the inside of a tooth, which is structurally similar to bone.  Elephant dentin, which is extremely large, makes for a good specimen, because human dentin is only a fraction of the inside of the tooth.

Dentin is believed to be a very hard structure, harder than that of human bone.  However, we would like to prove that there is elasticity involved with dentin.  This could help make strides towards improving the lives of people with diseases that cause weak teeth such as  *dentinogenesis imperfecta type II*, or even people with bone diseases such as osteoporosis, or other bone diseases since dentin is so similar to bone.

Overview of Ulrasonics

Ulrasonics is the application of the energy of sound waves vibrating at frequencies greater than 20,000 cycles per second, which is beyond the range of human hearing. The application of sound energy in the audible range is limited almost entirely to communications, since increasing the pressure, or intensity, of sound waves increases loudness and therefore causes discomfort to human beings. Ultrasonic waves, however, being inaudible, have little or no effect on the ear even at high intensities. They are produced, commonly, by a transducer containing a piezoelectric substance, such as a quartz-crystal oscillator, that converts high-frequency electric current into vibrating ultrasonic waves. Ulrasonics has found wide industrial use. For nondestructive testing an object is irradiated with ultrasonic waves; variation in velocity or echo of the transmitted waves indicates a flaw. Fine machine parts, ball bearings, surgical instruments, and many other objects can be cleaned ultrasonically. They are placed in a liquid, for example a detergent solution or a solvent, into which ultrasonic waves are introduced. By a phenomenon called cavitation, the vibrations cause large numbers of invisible bubbles to explode with great force on the surfaces of the objects. Film or dirt is thus removed even from normally inaccessible holes, cracks, and corners. Radioactive scale is similarly removed from nuclear reactor fuel and control rods. In medicine ultrasonic devices are used to examine internal organs without surgery and are safer to genetic material than X rays. The waves with which the body is irradiated are reflected and refracted; these are recorded by a sonograph for use in diagnosis. Metals can be welded together by placing their surfaces in contact with each other and irradiating the contact with ultrasound. The molecules are stimulated into rearranged crystalline form, making a permanent bond. Contrary to electromagnetic waves, such as light waves, mechanical waves such as ultrasound or other sound waves travel faster in more dense mediums.

Ultrasound, or sonography in medicine, is a technique that uses sound waves to study and treat hard-to-reach body areas. In scanning with ultrasound, high-frequency sound waves are transmitted to the area of interest and the returning echoes recorded. First developed in World War II to locate submerged objects, the technique is now widely used in virtually every branch of medicine. In obstetrics it is used to study the age, sex, and level of development of the fetus and to determine the presence of birth defects or other potential problems. Ultrasound is used in cardiology to detect heart damage and in ophthalmology to detect retinal problems. It is also used to heat joints, relieving arthritic joint pain, and for such procedures as lithotripsy, in which shock waves break up kidney stones, eliminating the need for surgery. Ultrasound is noninvasive, involves no radiation, and avoids the possible hazards such as bleeding, infection, or reactions to chemicals of other diagnostic methods.

Velocity of Sound in Various Biological Materials

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| Material | Speed of Ultrasonic Waves (m/s) | Impedance (Rayl x 10-6)�� |
| Air | 330 | .0004 |
| Fat | 1450 | 1.38 |
| Water | 1480 | 1.48 |
| Average Human Tissue | 1540 | 1.63 |
| Brain | 1540 | NA |
| Liver | 1550 | 1.65 |
| Kidney | 1560 | 1.62 |
| Blood | 1570 | 1.61 |
| Muscle | 1580 | 1.7 |
| Lens of Eye | 1620 | NA |
| Skull Bone | 4080 | 7.8 |

Impedance is the ratio of the sound pressure in a medium to the velocity of the particles in the medium. As stated in the table, the velocity of ultrasonic waves in air is significantly less than in denser mediums. From this information, we can confidently hypothesize that excess between fibers of dentin will make a significant difference in the velocity of ultrasonic sound waves.  Compressing the bone will result in the release of any air sandwiched between the fibers inside the dentin, thus could theoretically increase the velocity of the ultrasonic waves traveling through it.  If this occurs, the structure is variable.