

Calcification of Heart Valves

Purpose:

The endurance of a heart valve is affected by the health of the tissue. Calcification is a diseased state which for reasons demonstrated in this lab reduces the flex life of the heart valve.

Materials:

Plastic Jar with lid (> 2.0" diameter lid)
1 inch hole saw
Cardboard (> 0.050" thick)
Craft foam
Scissors
Scalpel
Vaseline
Rubber stopper
2" Binder clips
Butter knife
Uncooked lasagna noodle
Method to boil and drain water

Steps:

1. Cut stopper into 1/8" thick sections with scalpel.
2. Lubricate one side of the cut stopper with gasoline and place the lubricated side in the center of the uncooked lasagna.
3. Repeat above step and place on opposite side of lasagna, opposite side of previously placed stopper.
4. Clamp two stopper pieces together (with uncooked lasagna between) with 2" binder clip.
5. Boil Lasagna approximately 7 minutes.
6. Mark center of lid.
7. Using the 1 inch hole saw, cut a hole in the lid centering with previously placed mark.
8. Using the lid as the pattern, trace the outer diameter of the lid and the 1 inch hole on both the cardboard and foam pieces.
9. Cut the cardboard on the circles as traced.
10. Cut the foam approximately 2-3mm larger than the outer diameter of the lid. Cut the 1 inch hole as traced.
11. Drain water and straighten noodle on surface. Allow to cool for approximately 5 minutes.
12. Carefully remove the binder clips and stoppers from the cooked lasagna. The uncooked portion left behind will serve as your calcified tissue.
13. Trim the lasagna to fit on the cardboard cut-out (Rectangular shape). The hard uncooked portion of the lasagna should be in the middle of the cut out.
14. Place the lid on a table with the threads exposed.
15. Place the cardboard into the lid

16. Place the lasagna noodle on the cardboard. (The hard spot should align in the center of the hole)
17. Stuff the cut-out foam over the lasagna. Keep the foam as flat as possible in the middle and tuck it down around the sides of the lid.
18. Place the jar on the lid, screw the lid until resistance is felt, then you can upright the jar.
19. Squeeze the jar to flex the lasagna.
20. Record the number of cycles to failure of a thoroughly cooked sample verses a sample with a (calcified) hard spot.

Discussion Points:

1. Where does the failure occur? Notice the hard portion does not crack due to it being more brittle. The failure occurs where the soft portion meets the hard portion, and this is more likely due to the stress concentration between the two dissimilar materials. How large does the hard portion have to be to crack before failure occurs between where the hard and soft materials meet? What happens if you undercook the lasagna and the soft portion is not as soft? What happens if there are several calcified spots on the tissue?
2. Every model has its limitations. What are the similarities as well as limitations of this model?
Similarities: The diameter of the valve orifice is approximately 1 inch. Cyclical loads were applied
Limitations: Pressure measurements were not obtained. Lasagna is structurally different to heart valve tissue. There was no fluid flow.
3. A limited durability induced by primary structural failure remains a problem associated with bioprosthetic heart valves. By understanding the mechanism of the failure, how could these valves be improved?