Scientific Salon 3

HISTOLOGICAL AND BIOMECHANICAL PROPERTIES OF POLYPROPYLENE AND POLY-4-HYDROXYBUTYRATE GRAFTS IN THE RABBIT ABDOMEN AND VAGINA: 3 AND 9 MONTH TIME POINT.

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Objective: To evaluate the histological and biomechanical properties of permanent mesh, polypropylene (PP), compared to absorbable monofilament mesh, poly 4-hydroxybutyrate (P4HB), implanted in the rabbit abdomen and vagina at the 3 and 9-month time point.

Methods: After obtaining IACUC approval (2016-045), 16 New Zealand White retired breeder rabbits were anesthetized, shaved, sterilely prepped and draped. Animals were divided between 2 groups with 8 rabbits in each time point. Group 1 had PP mesh (Upsylon, Boston Scientific) implanted in the anterior vagina and P4HB (Tepha) implanted in the posterior vagina. Group 2 had P4HB mesh implanted in the anterior vagina and PP implanted in the posterior vagina. 2 out of 4 animals in each group had 2 implants of PP and 2 implants of P4HB implanted in the anterior abdominal wall fascia. Rabbits were sacrificed at 3 and 9 months post-implantation. Gross necropsy was performed. Half of the specimens underwent histological analysis and half biomechanical testing. Samples for histological analysis were stained with hematoxylin-eosin (H&E), Masson's trichrome, Elastin, and Picrosirius red. Samples were scored by a blinded pathologist for acute and chronic inflammation, collagen deposition, and elastic content using a 0-3 score, 0 meaning no inflammation, collagen deposition or elastic content. The collagen I/III ratio was calculated using Image J. An Instron material testing machine (Model #5566) was used to perform biomechanical load to failure testing of the implants. Descriptive statistics for histological characteristics were calculated for each group. The Wilcoxon signed rank test was used to compare biomechanical testing results within the same time point. A result was considered statistically significant at the $p < 0.05$ level of significance.

Results: 1 rabbit assigned to the 9-month time point was sacrificed at 6 months due to unexplained weight loss, this rabbit was excluded. At 3 months, there were 2 PP and 3 P4HB vaginal mesh exposures while at 9 months, there was 1 PP and 1 P4HB vaginal mesh exposure. Mean histology scores for acute inflammation, chronic inflammation, collagen deposition, and elastic for vaginal samples at 3 months (PP= 0,1.5,1.5,1.5 vs P4HB= 0,1.33,1.33,1.66) and 9 months (PP= 0,1.0,1.33,0 vs P4HB= 0,1.0,1.5,0,) did not differ. At 3 and 9 months the abdominal groups also did not differ. The collagen I/III ratio did not differ at 3 and 9 months. The mean stiffness of PP (1.70 N/mm) vs P4HB (3.25 N/mm) in the vagina at 3 months did not differ (p<0.375), and PP (3.73 N/mm) did not differ from P4HB (3.92 N/mm) at 9 months (p< 1.000). Young's Modulus did not differ between PP and P4HB at 3 months, (0.23 MPa vs 0.42 MPa, p<0.625) nor at 9 months (0.99 MPa vs 0.29 MPa, p< 0.250). The mean ultimate tensile strength (load at maximum tensile stress) of PP (4.98 MPa) to P4HB (6.07 MPa) in the vagina did not differ at 3 months (p<0.625), or at 9 months PP (11.16 MPa) vs P4HB (7.01 MPa) (p< 0.250).

Conclusions: The overall tissue response to PP and P4HB implanted in the rabbit abdomen and vagina at 3 and 9 months do not differ. Further data including 18 month histological and biomechanical analysis will help elucidate if there are differences between PP and P4HB.

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Scientific Salon 4

DETERMINING THE ACCURACY OF FOUR METHODS OF MEASURING THE RADIAL THICKNESS OF THE VAGINAL MUSCULARIS

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Objective: The vaginal muscularis is essential to the vaginal wall that imparts tone and contractility. Atrophy and dysfunction occur with aging, menopause, and the use of certain graft materials; thus, precise measurements of its thickness are critical for research outcomes. Current manual measurements of its thickness are time consuming and subject to error. To improve the method of measuring the vaginal muscularis thickness, we compared 4 methods that quantified radial thicknesses of virtual shapes (Manual, Inner to Outer Border Closest Point (IOBCP), Outer to Inner Border Closest Point (OIBCP), and Deformetrica).

Methods: 12 virtual objects resembling vaginal muscularis were created in Autodesk Fusion 360 (Autodesk Inc., San Rafael, CA)—6 shapes of varied complexity with 2 different, uniform radial thicknesses for each shape. Radial thickness was measured at 20 points - a typical number of manual measurements needed to adequately describe a shape. While the 3 computational methods can measure thousands of thicknesses without increasing computation time, all methods only used 20 points for equipoise. For the Manual method, radial thickness measurements were made at self-selected locations by an experienced technician blinded to object dimensions. For the Closest Point methods, the inner and outer borders were described by densely packed points in Mathematica (Wolfram Research Inc., Champaign, IL). IOBCP radial thicknesses were measured as the closest point on the outer border to each point on the inner border. OIBCP radial thickness was measured the same way, but with the roles of the inner and outer border reversed. The Deformetrica method used Deformetrica (Durrleman et al. 2014), a shape mapping software, to locate corresponding points on each border; the distance between them representing radial thickness. The average percent error of each method was used for comparison.

Results: Figure 1 shows the percent error for each method and shape. Overall, the Manual method had the smallest average percent error at 0.03%, followed by OIBCP with -0.73%, IOBCP with -0.80%, and Deformetrica with the highest at 4.36%. A trend between shape complexity and the percent error of the Deformetrica method was observed, but the other methods appear fairly consistent across all shapes.

Conclusions: The Manual method was the most accurate in measuring radial thickness; however, all methods but Deformetrica had an acceptable average percent error less than 1. When many thickness measurements are required, using either Closest Point method will afford a more rapid analysis with only a slight increase in error. Ongoing studies will compare these methods when measuring vaginal muscularis samples and across observers with varied levels of experience.
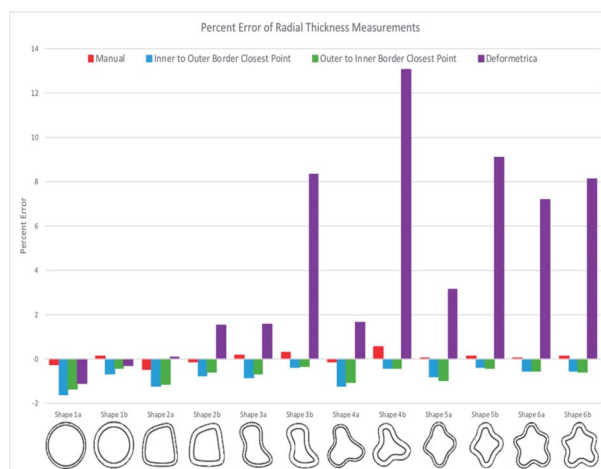

Figure 1: Displays the percent error of each radial thickness measurement method for each object. The x-axis is organized from left to right by increasing radial thickness and shape complexity.

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