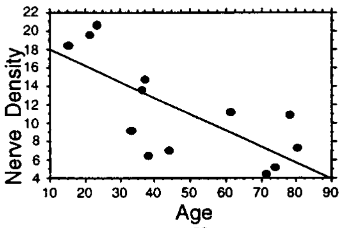
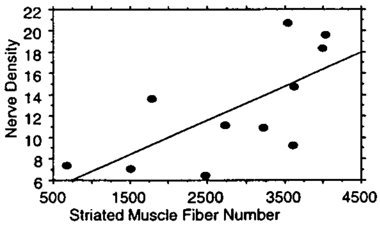
Reduced nerve density significantly correlated with fewer muscle cell numbers (P = 0.02) (see right graph below). Nerve Density also declined with increasing age (p=0.004) (left graph). There were fewer nerves in parous women, (mean 199, SD = 125, range 72-396) than in the nulliparous women (324, SD = 127.8, range 224-543 p<0.05). The larger nerve fascicles were seen predominantly in the distal half (13.1 axons per nerve, ± 5.7) as compared with the proximal part of the SUGS (1.2, ± 2).



Y = 19.754 - .176 * X; R^2 = .53



Y = 3.667 + .003 * X; R^2 = .471

Conclusions: There is considerable variation in the quantity of neural tissue among individuals. Reduced nerve density correlates significantly with reduced muscle fibers and with advancing age. Larger nerves lie at the distal end of the striated urogenital sphincter suggesting that the nerve supply to the SUGS travels up from the urogenital diaphragm. *Comment*: This data associates decreased nerve density in the SUGS with reduced striated muscle mass. The association between decreased neural tissue and advancing age parallels the data we have reported in striated muscle mass (1). The presence of larger supply nerves in the distal urethra is consistent with supply of this portion of the urethra from the pudendal nerve rather than from above by the pelvic autonomic nerves that descend from above. This helps explain why muscle is lost near the vesical neck where the muscle lies furthest from the supply nerves (2).

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PULL-OUT STRENGTH OF REATTACHMENT SITES IN RECONSTRUCTIVE PELVIC SURGERY: A BIOMECHANICAL STUDY

Aims of Study: (1) to test the pull-out strength of various tissues commonly employed in reconstructive pelvic surgery, including vaginal wall fascia and muscularis, arcus tendineus fascia pelvis (white line), obturator internus fascia and muscle, ischial periosteum, Cooper's ligament, sacrospinous ligament, and presacral fascia (anterior longitudinal ligament) in female cadavers using a precision biomechanical measuring device (load cell transducer) while carefully controlling the vectors of pull and (2) to compare cadaver to cadaver variance for such variables as age, height, bone length and extremity diameter to possibly delineate predictors for pull-out strength.

Methods: Fifteen fixed female cadavers were dissected exposing the pelvic floor and side wall. A 30 pound push-pull force gauge transducer was used to measure the breaking force strengths of the vaginal fascia and muscularis at three separate sites: the level of the urethrovesical junction at the anterior vaginal wall, the lateral midvagina, and the two lateral surfaces of the vaginal apex. We sequentially tested the arcus tendineus fascia pelvis (white line), obturator internus muscle and fascia, ischial periosteum, and sacrospinous ligament, exposing each of these structures by layered dissections [1-4]. Cooper's ligament was tested at its insertion nearest the pubic symphysis and 2 cm latera. to this point. The arcus tendineus was tested half-way between the pubic symphysis and ischial spine. The fibers of the obturator internus muscle and fascia were also tested after dissecting off the arcus tendineus. The ischial periosteum was tested just lateral to the ischial spine, staying posterior to the course of the obturator bundle. We tested the sacrospinous ligament approximately 2 cm medial to the ischial spine. For the ten cadavers which were available for dissection of the presacral fascia, we sequentially tested the anterior longitudinal ligament and fascia over the sacral promontory S1, S2 and S3.

A single interrupted suture of #1 Prolene was placed through each of these tissues using 8 alternating square knots, leaving a 2 mm gap between the suture and the tissue. The hook of the force gauge was looped through this suture gap. Traction was then applied to the force gauge transducer, while carefully controlling the vectors of pull at 90° angles to the plane of the tissue being tested, until the suture pulled through each site. The pull-out strengths of all these sites were recorded.

The mean pull out strengths and standard deviations for each cadaver were calculated at each anatomical site. An analysis of variance between physical characteristics of the cadavers, such as age, height, bone length, and extremity diameter, was undertaken to attempt to predict which variables may correlate with pull out strength using the Mann-Whitney test.

Results: The mean pull-out strengths of the vagina were as follows: urethrovesical junction (16.8 ± 3.7 lbs), midvagina (16.2 ± 4.9 lbs), and apical vagina (18.4 ± 5.3 lbs). The mean pull-out strength of the other structures tested were as follows: sacrospinous ligament (27.1 ± 3.2 lbs), ischial periosteum (26.5 ± 3.5 lbs), Cooper's ligament (25.9 ± 4.2 lbs), arcus tendineus (22.8 ± 2.5 lbs), obturator internus muscle and fascia (17.2 ± 3.6 lbs); presacral fascia at the sacral promontory 33.2 ± 2.1 lbs, at S1, 23.4 ± 5.6 lbs, at S2, 16.7 ± 8.5 lbs, and at S3, 10.5 ± 8.3 lbs. The arcus tendineus was not identified in 2 of 15 (13%) of the specimens. We also observed that forces of 4-5 lbs caused the arcus tendineus to become disrupted from the underlying obturator internus muscle in most cadavers. A similar observation was made when testing the obturator internus muscle; approximately 8-9 lbs of force caused it to separate from the underlying bony pelvis. This phenomenon was not observed with any of the other sites tested. Some stretching was also observed in the vaginal sites but this was not easily measurable. The obturator internus muscle showed some specimen to specimen variability in both thickness and strength. Minor variations were observed in pull-out strength of structures on the contralateral sides of the cadavers tested. Multivariate regression analysis of age, cadaver height, bone length and extremity diameter did not correlate with any of the values for pull-out strength.

Conclusions: Our data suggest that (1) the sacrospinous ligament, ischial periosteum, and Cooper's ligament are the strongest reattachment sites in the pelvis, (2) the arcus tendineus was not consistently found in all cadavers, (3) the arcus tendineus and the obturator internus muscle and fascia also manifested relatively high pull-out strengths, but were limited by our observation that they tore away from the underlying tissues at relatively low levels of force (4- 8 lbs), (4) the vaginal wall fascia and muscularis is weaker than the reattachment sites, (5) there was little difference in pull-out strength of the respective contralateral structures, (6) the strongest presacral fascia is at the sacral promontory. There is an incremental decline in thickness and strength in this fascia progressing caudad. Although S2 and S3 represent preferred anatomical sites for reattachment of prolapsed pelvic organs, based on the vaginal axis [5], they are somewhat weaker sites, and (7) we found no correlation by analyses of variance with age, height, bone lengths or extremity diameters which could predict pull-out strength.

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