

A BIOMECHANICAL STUDY OF THE STRENGTH OF BIOLOGICAL TISSUES USED IN SURGICAL TREATMENT OF PROLAPSE.

Hypothesis / aims of study

To measure the forces at tear of pelvic ligaments used in the surgical treatment of prolapse and urinary incontinence and the tensile and bending strength of samples of vaginal tissue collected during corrective surgery of prolapse.

Study design, materials and methods

We performed our measurements on pelvis ligaments from cadaveric specimens. In each cadaver we dissected pre-vertebral ligaments at promontory and right and left symmetrical ligaments. These were the iliopectineal, sacrospinous and arcus tendineus of pelvic fascia. A subjective clinical evaluation of the ligament properties was performed by visual observation as well as finger palpation. Ligaments were classified into three groups according to their quality. Then the ligaments were switched by a suture taking the entire ligament and a force was applied on the vagina axis until tearing. The device used for strength measurement during traction was a force gauge. Measurements were given in Newton.

The second part of the study is the measurements of the pressure and tensile strength curves on the vaginal tissue elongation. We conducted our measurements on two samples of vaginal tissue two cm by two collected during surgical correction of prolapse by vaginal route in 16 post-menopausal patients. The samples were collected from posterior vaginal fundus, were orientated, and then fixed on a plate holding the edges and allowing the tissue to be stretched over an orifice of one centimetre. The tensile measurements were made using a suture passed over this distance of one centimetre in one of the two samples by recording the strength curve in order to evaluate the force at rupture of the collagen fibres. The second sample was prepared in the same way and a piston of one centimetre diameter was made to penetrate to determine the strength of breakage of the fibres. The pressure and tensile strength curves were recorded up to rupture of the sample, as was the value of the tissue elongation.

Results

There was a great variability in the values obtained at tearing with minimal values at around 20 Newton and maximal values at 200 Newton. Individually measured, ligament strength varied between individuals, and for a same patient between the type of ligaments and the side. The pre-vertebral ligament was on average the strongest. There was no significant difference according to the storage condition except for the pre-vertebral ligament in formalin cadavers. For bilateral ligaments, there was no difference between the left and right side. The iliopectineal ligament was statistically significant stronger than sacrospinous and arcus tendineus of pelvic fascia. There was a correlation between subjective evaluation and objective strength measurements.

There was also a great variability in the measurements of maximum strength at rupture of the vaginal samples and in the elongation before rupture of the samples. The mean rupture values in tensile tests were 44 N and 59 N in bending with extremes of 12 and 130 Newtons. The values of elongation before rupture of a 10 mm sample were 23 mm in tensile tests and 11 mm in bending tests. There was a great variability of results from one patient to another. There was no relation between the values observed and the patient age. There was a statistical relation between the elongation values of the samples and the maximum force before rupture in both the tensile and bending tests. There was also a relation between the

measurement of the maximum force at rupture in bending and in tensile tests although there was no such relation in terms of the values of elongation before rupture.

Interpretation of results / Concluding message

There is no published reference concerning the strength at rupture or the tensile strength curves for human vaginal tissues or the strength of pelvic ligaments at tearing. Vaginal tissues are however commonly used as a suspension component in the vast majority of operations for correcting prolapse or urinary incontinence and the ligament are however routinely used to in place of suspension. The results that we report do however show that these biologic tissues used in cures of prolapse and urinary incontinence are very variable in strength from one patient to another. There is a great variability in strength between individuals, and for a same patient between the types of ligaments and side. The same finding was made in terms of the elongation values for the vaginal tissue before rupture. The values in bending tests showed that the highest rupture force values and the greatest mean elongation before rupture were lower than in tensile tests.

These observations could explain some of the surgical intervention failures, which are all based on the tensile strength properties, and demonstrate the importance of per-operative strength evaluation of the biologic tissues used for suspension. Per-operative subjective evaluation on strength is related to objectives measurements and could be used to determine the type of ligaments to be used for surgical assembly suspension. Further studies are required to evaluate the importance, in term of surgical failure, of the elasticity of pelvic ligaments and vagina.