GLENOUMERAL ARTHROPLASTY: POLYESTER PROPERTIES AFTER METHYL METHACRYLATE CONTACT

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ABSTRACT

Objective: The authors studied the physical properties of polyester thread (ethibond) following methyl methacrylate contact in a biomechanics laboratory. Methods: Strain at rupture, elasticity and traction deformity were evaluated using an Instron 4482 machine. The student-t test was used for the statistical analysis. Results: There were no statistical differences between the two groups. Conclusion: It is concluded that methy metacrylate contact with polyester does not affect its elastic properties and traction resistance.

Keywords: Methylmethacrylate. Shoulder. Arthroplasty. Prostheses and implants.

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INTRODUCTION

The first evidence of the use of sutures by mankind dates back to 4000 B.C., in Ancient Egypt. Over time several materials such as hemp, human hair, pig bristles, cotton, animal gut, nylon, polyester and metal, among others, have been used to repair injured tissues. Today sutures still occupy a prominent position in the medical area. In this last century, after the invention of nylon and of polyester, the popularity of cotton and of treated natural fibers, such as polypropylene, polyglycolic acid and polyglactin 910, has spread.

Suturing is the method used to draw together and keep the tissues in contact until the natural healing process has acquired sufficient resistance to close the wound or compress blood vessels.

The official compendium of suture material producing industries is called "The United States Pharmacopeia". It serves as guide for the manufacturing of threads.

Sutures are classified in several manners:

The size is classified by its diameter that ranges from 10 to 12-0, where the first is the thickest and the last narrower than a strand of hair.

They can be absorbable, that is, sutures that perform their duty for a given period of time then are decomposed by the organism through a natural reaction of the foreign body type.

They can be non-absorbable, that is, sutures that are not decomposed by the natural action of the body. However, the rule should not be followed to the letter, since although nylons and silks are materials that decompose after long periods of time, they are classified as non-absorbable.

Sutures can also be classified as monofilament or multifilament, interlacing, twisted or braided. They can be dyed or colorless, coated or not.

OBJECTIVE

The aim of this study is to analyze the features of polyester thread before and after contact with methyl methacrylate, used frequently in shoulder arthroplasties.

MATERIAL AND METHODS

At the material resistance laboratory we tested the characteristics of number five, braided polyester suture thread, with thickness of 0.85mm, known as Ethibond. The lots used and their shelf life were recorded: L.06Z021 E.06/99 Val. 06/04; L.02Z015 E.02/99 Val.02/04; L.06Z021 E.06/99 Val. 06/04; L.05Z003 E. 05/99 Val.05/04; L.60X003 E.absent Val.06/03.

The orthopedic cement of Howmedica Surgical Simplex was used. See below the itemization of its constituents and the number of the lots used:

Liquid part:	Methyl methacrylate (monomer)	19.5 ml
	N, N-dimethyl-para-toluidine	0.5 ml
	Hydroquinone, USP	1.5 mg
Solid part:	Methyl methacrylate	30.0 gr
	Polymethyl methacrylate	6.0 gr
	Barium Sulfate E.P.	4.0 gr

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All the authors declare that there is no potential conflict of interest referring to this article.

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Initial tests were conducted using the Versat 500 machine from the manufacturer Panambra – Pantec. (Figure 1) The aim was for us to observe the force required to cause the complete rupture of the polyester thread. Five threads were used in this initial test and we detected that all ruptured at the level of the clip (Figure 2) at a mean distraction force of 92 N. Literature shows us that the polyester thread presents a much higher resistance than that encountered.[1] Therefore, after verifying the negative influence of the clip of the Versat 500 apparatus on the resistance of the threads tested, we began to use a second machine: the Instron 4482 coupled to the computer program Instron Series IX Automated Materials Tester - Version 7.43.00. (Figure 3) Special clips[2] were used to avoid damaging the threads during the tests. (Figure 4) For this purpose we used cylindrical clips around which the threads were looped and not superimposed. The thread was passed four times around the cylinder and four surgical knots were made at each end of the thread tested. All the threads tested as well as the orthopedic cement used were opened on the test day.

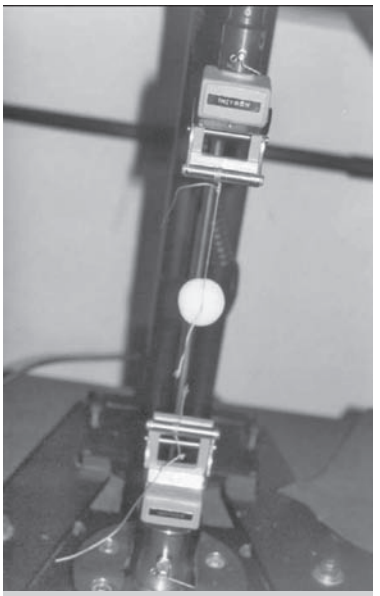

Figure 4 – *Special clips.*

Figure 1 –*Versat 500 apparatus.*

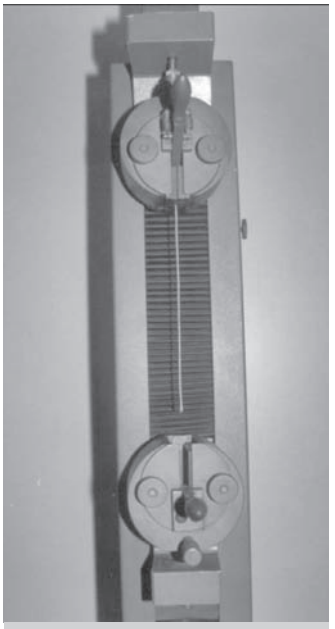

Figure 2 – *Rupture of the thread at the level of the clip.*

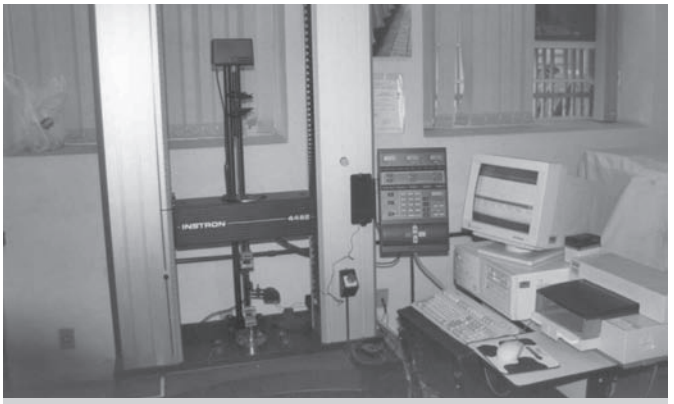

Figure 3 – *Instron 4482 apparatus.*

The distance between clips before the start of the tests was 22 cm.

The room temperature was 25 ºC and the traction speed was 2 cm/min.[2]

Two groups of threads were tested:

Group I (control group) and group II (group of threads that came into contact with the orthopedic cement). In each group twelve threads were tested mechanically until their complete rupture, having recorded the rupture site, namely: at the level of the orthopedic cement; between the cement and the clip; at the level of the clip or at the level of the surgical knot. The recording of the force applied throughout the test, as well as that of the deformity provoked in the thread, was executed by the computer. The deformity percentage analysis at the point of maximum force was also performed.

Statistical analysis

Three variables were used for the comparison between the two groups studied: rupture force (N), thread elongation (cm) and peak load strain (%). These variables were compared through the student's t-test[3] for independent samples, at a significance level of 5% (bilateral test). Besides the significance tests,[4] confidence intervals of 95% for the mean difference between the two groups were built.

RESULTS

The individual data of the experimental measurements of force, elongation and strain are in Tables 1 to 3. In Table 4 there is the statistical analysis (hypothesis test) comparing the two groups. In none of the variables was a statistically significant difference detected between the two groups: mean rupture force is the same ($p=0.698$), the mean elongation obtained is the same ($p=0.829$) and the mean peak load strain is the same ($p=0.982$). Besides the significance tests, the mean differences between the two groups, with the respective confidence intervals (Figure 5), were also calculated.

Table 1 – *Rupture (N) force.*

Ethibond	Group I	Group II
1	218	224
2	237	216
3	229	220
4	229	231
5	240	236
6	201	233
7	226	220
8	228	202
9	206	225
10	250	216
11	244	216
12	190	231
Mean	225	223
Standard deviation	18.1	9.6

Table 2 – *Thread Elongation (cm).*

Ethibond	Group I	Group Ii
1	4.94	5.55
2	5.24	5.69
3	5.00	5.28
4	5.26	5.41
5	6.69	4.61
6	5.26	4.98
7	5.24	6.83
8	5.93	6.17
9	6.27	6.07
10	6.53	5.99
11	5.94	6.00
12	5.41	5.77
Mean	5.64	5.70
Standard deviation	0.61	0.59

DISCUSSION

We have been using the polyester thread in daily practice for reinsertion of tendons and of the greater and lesser tubercles during shoulder arthroplasty procedures, when methyl methacrylate is also extensively used for stabilization of the humeral component. The migration of the tubercles is described in literature as a complication of this kind of procedure,[5,6] and it is attributed to the action of the musculature, mainly of the supraspinous and subscapularis muscles as well as to the poor quality of the bone tissue.[7,8] However, we have not yet observed any scientific article that demonstrates the effectiveness or resistance

Table 3 – *Maximum load strain (%).*

Ethibond	Group I	Group II
1	98.7	110.9
2	104.8	113.8
3	100.0	105.7
4	105.2	108.2
5	13.4	35.0
6	100.5	37.7
7	23.8	31.1
8	27.0	28.0
9	28.5	27.6
10	29.7	27.2
11	27.0	27.3
12	24.6	26.2
Mean	56.9	56.6
Standard deviation	39.9	39.4

Table 4 – *Comparative analysis between the two groups studied.*

Variable	Group	Mean Value	Standard deviation	p Value	Mean difference between the groups	Confidence interval of 95% for the difference
Rupture force (N)	I	225	18.1	0.698[a]	2	[-10; 15]
	II	223	9.6			N
Thread elongation (cm)	I	5.64	0.61	0.829[b]	-0.06	[-0.56; 0.45]
	II	5.70	0.59			cm
Maximum load strain (%)	I	56.9	39.9	0.982[b]	0.3	[-33.2; 33.9]
	II	56.6	39.4			%

N.B.: -a: student's t-test assuming different variances
-b: student's t-test assuming equal variances

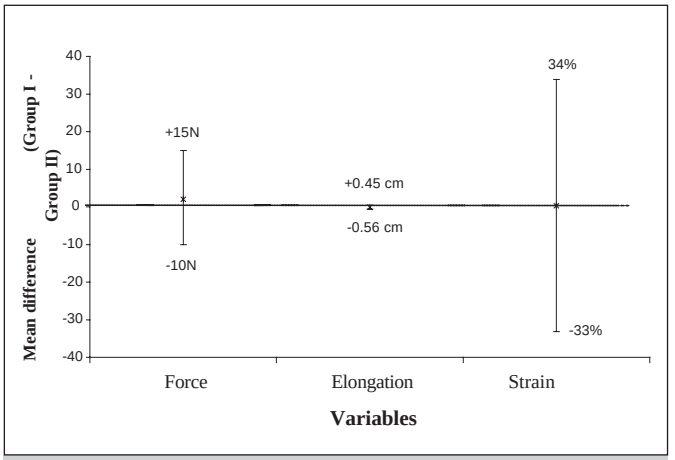

Figure 5 – *Confidence intervals of 95% for the mean difference of the groups.*

of the suture made with the polyester thread after it has come into contact with methyl methacrylate. Before this study we believed that the temperature increase caused during the drying process of the orthopedic cement could alter the characteristics of the polyester thread.

It is amazing how surgeons persist in using materials that are foreign to the body without knowing them properly. We had great difficulty in obtaining technical information about the suture threads that we use in daily practice. The actual industry that produces these materials does not provide information thereupon to the medical class that has passively accepted this situation.[9]

In studying the characteristics of polyester thread and its correlation with methyl methacrylate, we began to look at the looseness of the greater and/or lesser tubercles in the shoulder arthroplasty postoperative period from a different perspective. Accordingly we managed to challenge, with more precise data, the unsatisfactory results due to laxity of the tubercles in arthroplasties. Is the friction between the polyester thread and the implant the weak point that leads to rupture? We also observed in our daily practice that the polyester thread presents an important reduction in its resistance after having been compressed by the extremity of a needle holder or after having been inadvertently transfixed by a surgical needle. These are initial impressions that could determine the performance of other resistance tests of this material used so frequently in orthopedic surgeries.[10] The pursuit of new methods for tubercle fixation and of new materials used in suture threads is something that might reduce the level of laxity of the tubercles after shoulder arthroplasties in the near future.

CONCLUSION

The contact of methyl methacrylate with polyester thread does not entail changes in its elastic and traction resistance properties.

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