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Comparison of hemp and cotton fiber implants in muscle rat tissue. Study of the inflammatory response.

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Abstract. Hemp fiber is obtained from the plant *Musa textilis*. The cost of preparation of its raw fibers is low. The purpose of this paper was to compare the inflammatory response in the rat muscle tissue originated by both hemp and cotton fibers. Both types of fibers, were implanted in gluteal muscles of Sprague Dawley rats. The rats were sacrificed at 15, 30 and 60 postoperative days. Muscle tissue sections were stained with hematoxilyn-eosin. The inflammatory response was measured by subtracting the suture surface area from the total granulomatous area. At 15 days, the inflammatory response was more conspicuous for hemp than for cotton fiber ($P<0.05$). At 30 and 60 days, responses were similar ($P> 0.05$). We cannot conclude that the hemp fiber is superior to cotton,nevertheless, they behave the same. Therefore, hemp constitutes an alternative as suture material.

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INTRODUCTION

The cost of the suture materials have increased notably, that is why we have to find materials that can be produced and processed in the country, to lower the current prices. The generally accepted characteristics of an ideal suture material (1,4,5,6,7) include high tensile strenght in small caliber, sterilization which should be acomplished without alteration of the properties of the suture, knot security, excellent handling characteristics, minimal tissue reaction, absence of allergenic properties, resistance to infection and low cost. The hemp

fiber (9) is obtained from an asian plant named *Musa textilis*. "Manila hemp" or simply "Manila" are trade terms used in the United States. The fiber is extracted from the stems of hemp by a water retting process. The gums and pectin which cement the fibers together are dissolved, so that the fiber strands are freed from one another. After retting, the stalks are crushed and the fiber is combed out, leaving them ready to use. The purpose of this paper was to compare the inflammatory response of the hemp fiber with that of the cotton fiber, both of vegetable origin.

MATERIALS

Twelve Sprague Dawley rats with a weight between 150 to 250 g were fed "ad libitum". Sodium penthobarbital (Abbott Laboratories) in a dose of 37 mg/Kg of weight via intraperitoneal, was used as anesthetic agent. The hemp fiber is commercialized(Hanf UnionAG, Germany) in rolls of 100 g. The hemp fiber was cut, assembled in an atraumatic needle, sterilized and packed (Ethicon de Venezuela, Johnson & Johnson Medical). The cotton suture is commercialized by the same company and the diameters of both materials are 0.4 mm (Size 0).

METHODS

Each rat was anesthetized with sodium pentobarbital. The rats were placed in ventral decubitus position. A three - cm midline incision allowed the exposition of the gluteal muscles. The hemp fiber was implanted in the right gluteal muscle and the cotton suture in the left gluteal one, parallel and equidistant to the vertebral column. Groups of four rats were sacrificed at a term of 15, 30 and 60 postoperative days. The gluteal muscles with implants were excised and preserved in buffered formalin solution and embedded in paraffin.

Microscopic sections were processed histologically, obtaining 44 hemp fiber and 27 cotton fiber slides. All of them were stained with the hematoxilyn-eosin technique and placed in a glass slide projector. This projector has the ability to increase "n" times the size of the lamina at a "x" distance. The calculation was based on the πr^2 formula. We measured the diameter and calculated the cross sectional area of the inflammatory granuloma and the implanted material. The cross sectional area of the suture was subtracted from the area of the inflammatory granuloma, obtaining then, the area of the inflammatory response (Figs. 1,2). Statistical comparisons were made using Student T Test, with a significance of a $P<0.05$ (2).

RESULTS

No macroscopic abnormalities, directly attributable to the im-

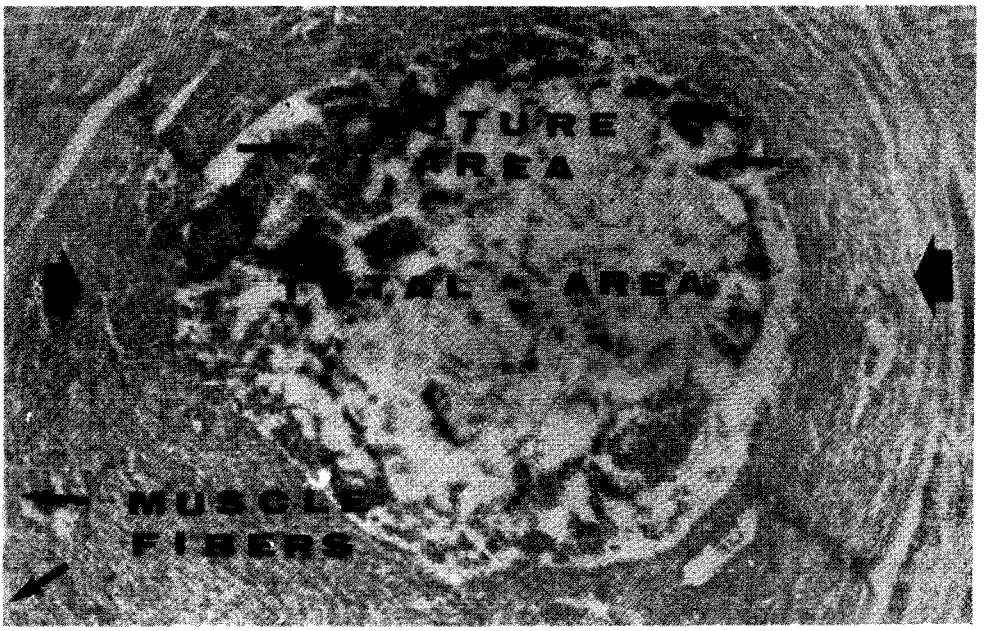

Fig. 1. Hemp fiber surrounded by inflammatory area response, after 15 days of implantation in rat muscle (HE x 63).

Fig. 2. Inflammatory area response (IAR) evoked by the implanted suture (HE x 100).

TABLE I
INFLAMMATORY RESPONSE TO IMPLANTS
OF HEMP AND COTTON FIBERS AT 15, 30 AND 60 DAYS

15 days (mm^2)		30 days (mm^2)		60 days (mm^2)	
Hemp	Cotton	Hemp	Cotton	Hemp	Cotton
2.39	0.76	1.33	0.95	0.81	0.94
±0.47	±0.14	±0.31	±0.28	±0.20	±0.22
n=12	n=5	n=13	n=9	n=19	n=13
P<0.05		p>0.05		p>0.05	

n= number of hystopathological slides analyzed in each group.
The figures represent the mean ±S.E.

planted sutures, were observed at any time. In this study, 44 specimens of hemp fiber and 27 specimens of cotton suture were obtained from the animals subjected to operation. The microscopic examination at 15 days (Table I), revealed that the area of inflammatory response of the hemp fiber was greater than that of the cotton fiber (P<0.05). However, at 30 and 60 days (Table I), the cross sectional areas of the inflammatory response of both materials were similar (P>0.05). The difference was not significant, so we conclude that both materials behave in a similar way.

DISCUSSION

Inflammation is the response of a vascularized tissue to local injury (8,10), in our case, to the suture material implanted. Whenever foreign materials, including sutures, are implanted in living tissues, a variable but inevitable cellular response occurs (11). This consists, during the first few days, of neutrophils that are replaced by a predominantly monocytic cell population, with a variable content of lymphocytes and plasma cells. Eventually, fibroblast and connective tissue proliferate. The acute reaction has been considered a result of trauma caused by the passage of the needle and suture through the tissues.

Between 10 and 15 days, the acute inflammatory reaction subsided, represented by a diminishing of the median of the area of the inflammatory response. The inflammation aim is to destroy or to isolate the nocive agent (Figs. 1,2).

The inflammatory response is not uniform. Its variation depends on the material used, time of implantation and specie. In the human (12), the inflammatory response is similar to the response in the tested animals, but less intense. The evaluation of the inflammatory response can be done by counting the cells responsible of the phenomenon or by measuring the inflammatory area's response (3,12).

At 15 days, the cellular reaction to the hemp fiber was more prominent than that associated with cotton suture ($P<0.05$). This difference might be due to the fact that the hemp fiber was not processed with the special coating procedure similar to that of other suture material. Also, the presence of braiding fibers afford to penetrate the inflammatory cells into the hemp threads (6,11). It seems that the high inflammatory response produced by the hemp fiber, is because it is absorbed faster than the cotton fiber, but this require further investigation.

The pattern of the cellular response at 30 and 60 days was similar in both hemp and cotton suture ($P>0.05$). We cannot conclude that the hemp fiber is superior to the cotton fiber, but we can affirm, on the basis of our results, that the tissue behaviour is similar; therefore, hemp could be used as an alternative to cotton.

It seems that the elaboration of the hemp fiber as suture material can be acomplished without complex steps as other suture materials. We suggest further investigations in order to evaluate the behaviour of the fiber studying other live tissues, laboratory animals, different fiber diameters and comparing them with other suture materials.

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RESUMEN

Estudio comparativo de la respuesta inflamatoria a los implantes de fibra de cáñamo y algodón, en músculo de rata. Dorfman, S. (Servicio de Cirugia General, Hospital General del Sur, Maracaibo, Venezuela), Dorfman, D.; Leonardi, R.; Maroso, J.; Cardozo, J.; Duran, A. *Invest Clin 35(1): 35 - 40, 1994.*

Palabras claves: sutura, cáñamo, algodón.

Los costos de los materiales de sutura han aumentado de precio en forma tan notable, que obliga la búsqueda de alternativas, que puedan ser producidos y procesados en el pais. La fibra de cáñamo se obtiene de una planta *(Musa textilis)*. Los costos de la preparación

de la fibra bruta son bajos. En este trabajo, se comparó la respuesta inflamatoria de la fibra de cáñamo y del algodón entejidomusculardela rata. Las ratas se sacrificaron a los 15, 30 y 60 días de la intervención. Las láminas histopatológicas fueron coloreadas con hematoxilina-eosina. La respuesta inflamatoria se cuantificó restando del área total del granuloma, el área de la sutura. A los 15 días del implante, la fibra de cáñamo presentó una respuesta inflamatoria mayor que la del algodón (P<0:05). A los 30 y 60 días las respuesta inflamatoria fue similar (P>0.05). No podemos concluir que la fibra de cáñamo sea superior al algodón, pero sí podemos afirmar que el comportamiento tisular es similar, por lo que constituye una alternativa frente al algodón.

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