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Preparation and Characterization of Surgical Mesh Using Polypropylene Yarns

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Abstract: *Surgical mesh is a medical device that is used to provide additional support to weakened or damaged tissue. The majority of surgical mesh devices currently available for use are constructed from synthetic materials or animal tissue, surgical mesh made of synthetic materials can be found in knitted mesh or non-knitted sheet forms. The synthetic materials used can be absorbable, non-absorbable or a combination of absorbable and non-absorbable material Permanent meshes remains in the body, whereas temporary ones dissolve over time. Surgical Mesh provides medical textiles for the manufacture of hernia mesh. polypropylene monofilament mesh were chose to repair hernia both for, physical performance, biological inactivity and compatibility, open knit construction allows in-growth of host tissues and encourages natural repair, Unique knitting mesh design, Flexible, strong, elastic transparent & mesh, non-absorbsorbable, inert and porous no shrinkage provides long term material stability important to counter muscular contraction and Excellent multi-directional mechanical properties and exceptional resistance to tearing. Generally, PP weft knitted mesh fabrics (50 courses per centimeter) were fabricated using (PASSAP DEUMATIC 80) weft knitting machine. The heat treatment conditions are confirmed on the basis of trials. It can be concluded that the heat treatment low temperature between and the time 5 minutes Second one uses the method fabric mesh passing from* ***ASTRON*** *machine fussing time = 20min ,tempure = 190 c° Speed = 5m/min,time = 10 sec, benefit the mechanical properties of the mesh. The prototype PP mesh were characterized the Geometrical characteristics,*

Keywords: polypropylene (PP), weft-knitting mesh fabric, heat treatment, Ethyl Alcohol (Et OH), mechanical properties, surgical mesh.

1. INTRODUCTION

In the past years, the application of bio-textiles for implants has greatly developed in the new field of tissue engineering. A shortage of organic implantations and the very high cost of the operation are presently the main problems in surgical implant operations. There is also the danger of sudden/shock rejection. In the past five years, about ten thousand persons have died while waiting for various tissue implants. For this reason, the role of synthetic polymers and textile structure in tissue culture has become increasingly important in the medicinal field. For example, using synthetic material to repair hernia has become the major method in operations to repair external hernias .Inguinal hernia repair remains one of the most commonly performed operations worldwide [1]. polypropylene monofilament mesh We chose to repair hernia both for, physical performance, biological inactivity and compatibility, open knit construction allows in-growth of host tissues and encourages natural repair, Unique knitting mesh design, Flexible, strong, elastic transparent & mesh, Non-absorbsorbable, inert and porous no shrinkage provides long term material stability important to counter muscular contraction and Excellent multi-directional mechanical properties and exceptional resistance to tearing [2]. The mesh structures are manufactured with 100% PP yarn using available (PASSAP DEUMATIC 80) flat weft knitting machine. The fabricated mesh was analyzed and the physical properties are measured and compared. Since the surface modification of surgical mesh becomes important when they come into contact with physiological components such as blood and living tissues, the samples were heat treatment and sterilized by Ethyl Alcohol (Ethanol).

2. MATERIALS AND METHOD

2.1 Polypropylene (PP)

Polypropylene is one of those most versatile polymers available with applications. Different PP grades are available dependent on the application and chosen processing method Polypropylene (PP) yarn was used to knit weft knitting mesh fabric [3].

Table 1: The PP yarn properties [4] .

Properties	Value
Material	100% Polypropylene
Style	Core Spun Yarn
Yarn Count	55D
Brand Name	Chiffon
Yarn Type	DTY
Technics	Ring Spun
Twist	20
Strength	3.5
Model Number	SF
Evenness	25

2.2ethylalcohol

Ethanol (ethyl alcohol, grain alcohol) is a clear, colorless liquid with a characteristic, agreeable odor. In dilute aqueous solution, but in more concentrated solutions it has a burning taste[5] .

2.3Weight and Thickness

The weight and the thickness of the PP mesh fabric were measured using electronic measuring devices. Samples were prepared in to length of 15cm width of 15cm, and then the weight gram per meter square was calculated from the Equation:

$$\text{Weight of sample}(\text{g/m}^2) = \frac{W'}{W * L} \times 1000$$

Where:

W' Weight (g)

. W width is of the sample (m)

L is length of the sample (m)

2.4 Ethyl Alcohol Content

Content of each sample calculated from equation :

$$\text{EtOH conten} = \frac{\text{weight of the pp mesh} - \text{wieght of pure fabric}}{\text{weight of pp mesh} * 100}$$

2.5 Porosity

The porosity (P %) of each sample calculated from the Equation: For PP weft knitted fabric mesh porosity was calculated directly from the density of each one.

$$\text{p}(\%) = 1 - [\frac{\text{M}}{100 * \text{TH} * \text{D}}] \times 100$$

Where:

M = mass per unit area of the sample (g.m2),

TH = sample thickness (mm)

D= density of the material (g.cm-3).

2.6 Tensile strength

The test performance according to Standard ISO 7198: 1998[78].

2.6.1 Mesh fabric tensile strength

For longitudinal direction the sample was held on device as shown in figure1, with the following setting: width: 5 cm,

Sample length: 20 cm, Length between clamps 5 cm .

Figure1: Raw mesh fabric tensile strength testing method

2.7 Samples Preparation

The PP fabrics were knitted using PASSAP DEUMATIC 80 weft knitting shown in figure 2

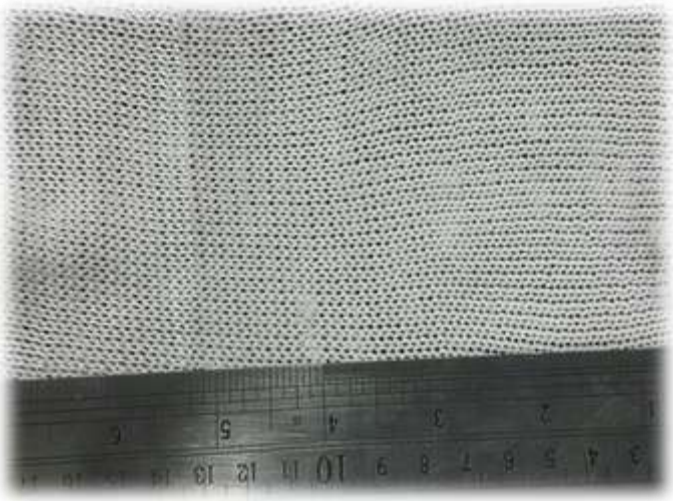

Figure 2: PP mesh of weft knitted

2.8 Heat treatment

Figure 3: Method of the heat treatment process

Is a process of combination heating and cooling operations time and applied fabric mesh passing from ASTRON machine obtain desired properties [6].

fussing time = 20min

temperature = 190 °C

speed = 5m/min

time = 10 sec

- **Purpose:**
  - Increase of strength and hardness
  - Improvement in dimension stability properties and toughness.
  - Increased softness.

2.9 Sterilization

This process is carried after treatment directly. The hernia meshes are available commercially in sterile packages for single use, and the re-use of remaining pieces are not recommended by the manufacturer [7].

2.9.1 Ethyl alcohol Preparation

mixture of alcohol, water is a typical sterility used in this method of sterilization.

Concentration (10%) show in figure 4

Figure 4: Method and preparation of the Sterilization process

2.9.2 Method of chemical sterilization

Impregnation the sample of EtOH solution (10%) at time 30 min in room temperature.

Figure 5: Method of the Sterilization process

2.10 sample Drying

After sterilization process, the samples were put into the refrigerator With 90˚C for 1 h.

Figure 6: The method of sample drying.

3. RESULTS AND DISCUSSION:-

3.1 PP mesh Fabric Characterization

Figure 3 shows an image of PP mesh of weft knitted. Which were analyzed to calculate the number of the loop in two directions (wale and course). The loop density of the fabrics has been determined by using calculator.

Table 2: The density of PP mesh weft knitted fabric

Wale/50mm	Course/50mm	Density/2500mm
77	50	3696

Figure 7: image of prototype PP mesh

3.2 Geometric Characteristic

The PP weft knitted mesh fabric and PP mesh after treatment Table 3 shows the thickness, weight, EtOH contan and porosity of mesh.

Table 3: Geometrical characteristic of PP Weft-knitted mesh fabric and mesh fabric after treatment and Prolene Standard

Sample	Thickness(mm)	Weight(g/m)	Porosity%	EtOH%	Ref
Mesh fabric	0.52	47.04	99.95	00.00	Our work
Mesh fabric after Treatment	o.2	82.22	99.96	24.19	Our work
Standard (Prolene)	0.31	82.5	49.73	-	[8]

Table 4 : Compared the break strength of the PP mesh surgical mesh and standard human vessels in longitudinal direction

No	Sample code	force (N)	Elongation at Break	Breaking length (mm)	Breaking strength (N/mm2)
1	Raw Mesh	75.6	55	310	0.65
2	Treatment Mesh	65	9	21.8	0.756
3	Standard human vessels	-	-	-	1.70 [9].

4. CONCLUSIONS

Polypropylene monofilament mesh is the best repair material which has so far been used in hernia repair operations and other abdomen defect operations. The goal of this study is to design and produce mesh of weft knitted g (50 needles) PP yarns and to study their physical properties. First, the structures were manufactured using a flat knitting machine according to a patented knitting process. The physical properties of such fabrics mesh were determined before and after heat treatment and sterilization process and the changes in their properties were noted. The found tensile strength it is week.

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