Advance Research in Textile Engineering

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Development of Knitted Gauze Fabric as Wound Dressing for Medical Application

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Received: December 18, 2017; **Accepted:** January 30, 2018; **Published:** February 06, 2018

Abstract

The textiles used in the operative and post-operative tasks in and around a patient and the medical practitioners are termed as Medical Textiles which application area embraces all those technical textiles used in health and hygiene applications. To cure healing of a wounded area traditionally sterilized or non-sterilized woven gauze fabrics are used directly or indirectly to the wound respectively mainly for absorbing the liquids of the wounded area. But in fact, knitted fabrics have a higher absorbing tendency rather than woven fabrics and thus knitted gauze fabrics also hold the potential for better absorbency than that of woven fabrics. In this research, knitted gauze fabricswith two typesof machine gauge (2.5 and 5) were developed with two different count (26/1 Ne and 30/1 Ne) of 100% cotton yarn to observe the blood absorbency compared to the commercial woven gauze fabrics.It was predictably found that the absorbency were higher for knitted gauze fabrics in respect to absorption percentage as well as absorption per gram of fabric. It was also observed that fabric made from lower count and higher gauge had better absorbency among the knitted fabrics.

Keywords: Wound dressing; Woven gauze fabric; Knitted gauze fabric; Blood absorption; Sterilization

Introduction

Traditionally the term 'Textile' was devoted to fabric or especially woven fabric produced from yarns which were made from natural fibre [1-2]. However, in the modern ages, textiles are mainly subdivided into tradional and technical textiles. Traditional textiles are mostly the daily life used clothing and garments whereas technical textiles are used for specific functional purposes. These technical textiles are distinguished into some subclasses such as agricultural textile [3], medical textile [4], geotextile [5], home textile [6], protective textile [7], structural textile [8], sports textiles [9] *and*eco textiles [10].

Globally technical textile is one of the fastest growing sectors. Now-a-days several types of high-value-added textile products are manufacturing all over the world. With the combination of textile technology and medical sciences, a new branch of technical textile known as medical textile is emerging day by day [11-13]. Development of medical textiles can be considered as one such development, which is really meant for converting the painful days of patients into the comfortable days. Medical textile represents structures designed and accomplished for a medical textile. The areas of application are diverse, ranging from a single thread suture to the complex composite structure for bone replacement and the simple cleaning wipe to advanced barrier fabrics used in operation theatre [12].

Medical textiles are mainly classified into four ways such as healthcare and hygiene products, extracorporeal devices, implantable materials and non-implantable materials. Healthcare is a serious business which is not only influenced by practical professionals but also by the manufacturers of diversified medical products [13]. Strength, extensibility, flexibility, suppleness, air and moisture permeability are the prime properties which are required for the development of a health and hygienic product [14]. A bandage is a piece of material either to support a medical device such as addressing or splint, or on its own to provide support to the body [15].In general term, the word "bandage" is often used to signify a dressing, which is used directly on a wound, whereas a bandage is technically only used to hold a dressing and not directly on a wound [16]. The gauze and bandage fabric are very important in health care issues. It mainly uses for the healing purpose of the human body [17].

To make this gauze and bandage fabric 100% germ-free, various types of sterilization processes are carried out namely thermal/heat (dry heat and moist heat) sterilization method radiation sterilization method, ethylene oxide sterilization method and hydrogen peroxide sterilization method [18]. Coatings are also useful to enhance different properties of gauze fabric. Microbial cellulose coated gauze fabrics were reported to have a 30% increase of absorption and wicking as well as 33% reduction of drying time [19]. Gauze fabrics coated with antimicrobial polymers like chitosan, calcium alginate and sodium alginate found improving the wound healing rate significantly [20]. As woven gauze fabrics are very common in medical uses, there are numerous research available in this regard to enrich its properties. However, in between woven and knitted fabric, later one is proven with better capability of absorption due to its inherent structure. In the same way, in terms of gauze fabrics used in medical purposes, it is likely to get superior results for knitted gauze fabric over market available woven gauze fabrics. But surprisingly, knitted gauze fabrics are rare in use and in research arena. Therefore, in this current research work, novel knit gauze fabrics were manufactured followed by evaluation of their blood absorption performance in comparison with available woven gauze fabrics in local market. This work is unique as it reveals the unexplored potentiality of knitted gauze fabric in medical application.

Citation: Alam SMM, Faruque MAA, Sarker E, Sowrov K, Alam T and Haque ANMA. Development of Knitted Gauze Fabric as Wound Dressing for Medical Application. Adv Res Text Eng. 2018; 3(1): 1021.

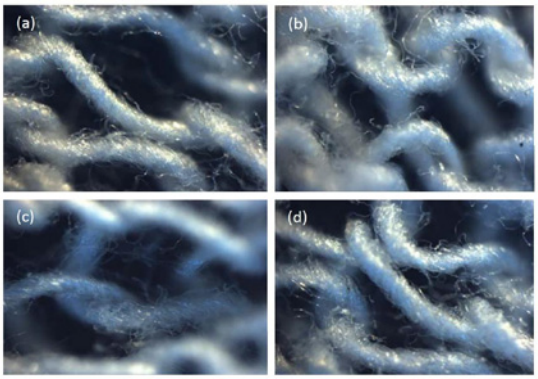

Figure 1: Microscopic view of knitted gauze fabrics produced from (a) 26/1 Ne, 2.5 gauge (b) 26/1 Ne, 5 gauge (c) 30/1 Ne, 2.5 gauge and (d) 30/1 Ne, 5 gauge.

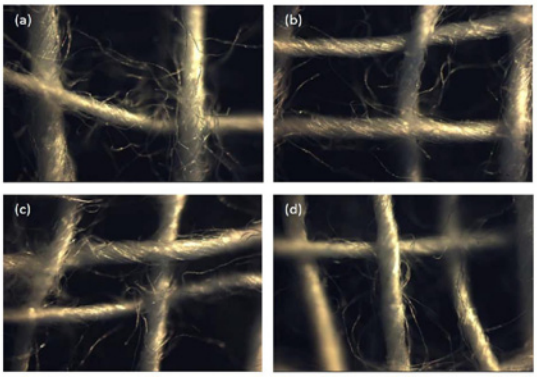

Figure 2: Microscopic view of commercial woven gauze fabrics in Bangladesh (a) Muktaplus (b) BSMI (c) AL-ABI and (d) PTI.

Methodology

Fabric preparation

Knitted gauze fabric was produced with half and full needle mechanism by using 26/1 Ne and 30/1 Ne 100% cotton yarn. For this purpose a knitting machine was used which has 4.5 inch diameter with 2 feeders and 84 needles capacity. Both 2.5 and 5 gauges were considered for knitting of gauze fabrics and named as A type and B type respectively. The specifications of those knitted fabrics are listed in (Table 1).

For comparing with traditional woven gauze fabrics, four samples of commonly used woven gauze fabric brands were collected from local markets. The brands are namely MUKTAPLUS, BSMI, Al-ABI and PTI. The composition, GSM and construction of above fabrics are listed in (Table 2).

Both types of fabric were observed under a PROJECTINA DMM2000 digital microscope and the images obtained are shown in (Figure 1, 2).

Scouring bleaching and sterilization

The knitted fabrics were scoured for removing natural impurities with 5 g/L NaOH, 3 g/L Na_2CO_3, 2 g/L detergent in presence of 1 g/L wetting agent and 1 g/L sequestering agent at 95°C for 60 minutes with 1:20 MLR (material liquid ratio). The bleaching process was

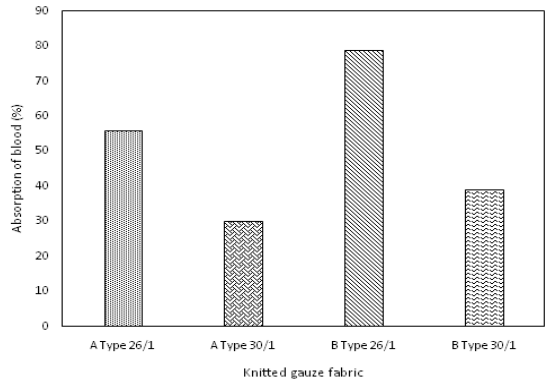

Figure 3: Absorption percentages of blood onto knitted gauze fabrics.

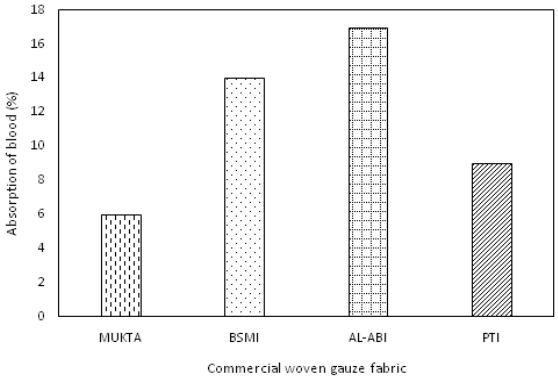

Figure 4: Absorption percentages of blood onto woven gauze fabrics.

carried out by 5 g/L H_2O_2, 0.5 g/L Stabilizer and 3 g/L Na_2CO_3 with 1:20 MLR at 90°C for 60 minutes. After that the sterilization process was carried out of at M.H. Samorita Medical College and Hospital, Tejgaon, Dhaka, Bangladesh by Moist heat sterilization method at 134°C and 15 atmospheric pressure for 30 minutes.

Measurement of absorbency

The absorbency test of the fabric samples was performed as per the protocol described in the British Pharmacopoeia, 1995 (BP1995) [21]. At first, a sample of 5cm × 5cm was weighted (W_1) in gram. Then by using forceps, the material being tested was suspended for 30 seconds by one corner and then reweighted (W_2) in gram. The absorbency was calculated and expressed as the weight of blood retained (W_2-W_1). Five samples were tested for each company. 1 ml of blood was used for each of the test. The Absorption percentage (A) was calculated by the following formula-

$$A\%=Y/X\times100$$

where, X is the initial amount of blood considered for the test (ml) and Y is the amount of blood absorbed on the fabric (ml) which was obtained from W_2-W_1 value above. In this case, 1 ml blood was considered equivalent to 1 gm weight as the density of blood is nearly equal to the water density [22]. Absorption per unit of fabric, C (ml/g) was calculated through the following formula-

$$C=Y/W_1$$

where, Y and W_1 are as stated above. All these experiments were

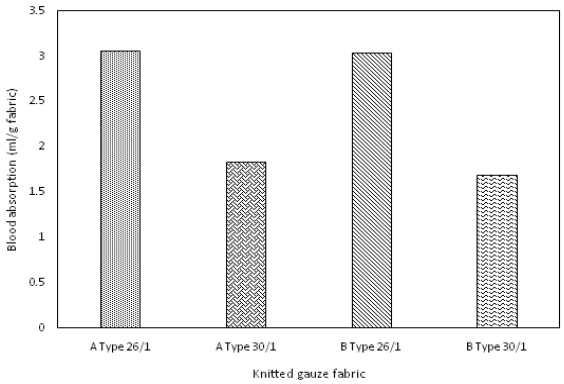

Figure 5: Absorption of blood onto per unit weight of knitted gauze fabrics.

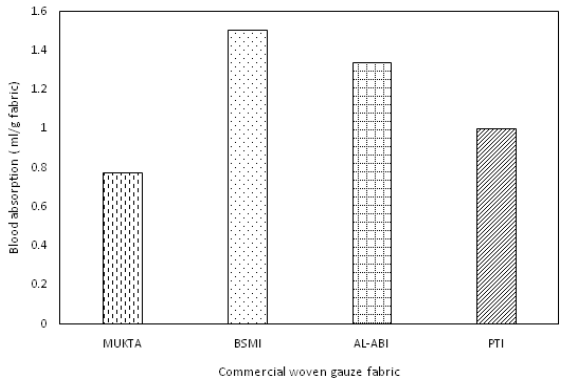

Figure 6: Absorption of blood onto per unit weight of woven gauze fabrics.

performed in triplicate method and average of the values were considered for calculation.

Result and Discussion

Absorption percentage

From (Figure 3), it is observed that, 26/1 Ne Type A knitted gauze fabric is showing more absorbency than 30/l Ne Type A knitted gauze fabric due to coarseness in cross section of 26/1 yarn. Similarly, it is seen that for 26/1 Ne Type B knitted gauze fabric is showing more absorbency than 30/l Ne Type B knitted gauze fabric because of yarn coarseness. So undoubtedly there is a direct relation between yarn count and absorption. Again in respect to machine gauge, it is seen that for 26/1 Ne Type A knitted gauze fabric is showing less absorbency than 26/l Ne Type B knitted gauze fabric. As wales per inch, course per inch & GSM of 26/1 Ne Type B is higher than that of 26/1 Ne Type A fabric the absorbency of 26/1 Ne Type B is better. Similarly it is clear that 30/1 Ne Type B fabric show higher absorbent tendency rather than 30/1 Ne Type A. The absorbency of commercially available woven gauze fabrics were very poor in comparison with the developed knitted gauze fabrics which are shown in (Figure 4).

Absorption per unit weight of fabric

When the data is analysed in terms of absorption per unit weight of fabric, almost same results are revealed. Coarser yarns are found to be greater absorbent and higher gauges produced better absorption capability. Results are depicted in (Figure 5) and are found far better when compared with the results obtained from the commercial woven gauze fabrics in (Figure 6).

From above results of developed knitted gauze fabrics and market available woven gauze fabrics, it can be suggested that knitted gauze fabric is more effective for the healing purpose of a wound from the perspective of absorbency in the medical sector.

Conclusion

Fetching comfort to a patient in the painful days of sufferings from various diseases, the application of textiles (in the form of fibre, yarn or fabric) named as medical textile is unavoidable. The numerous kinds of medical textiles can be applied from simple hygienic purpose to complicated process of replacing body organs. Gauze fabric is one kind of medical textile that is mainly used in both operative and post-operative stages for the absorption of blood to quicken wound healing process. In general, woven gauze fabrics are mainly used for this purpose, however, by this research work it is found that the absorption performance of novel knitted gauze fabric is better than the traditional woven gauze fabric. In addition, it is also observed that the knitted gauze fabrics made with full needle have better absorption capability rather than the half needle. Moreover, from our experimental results it can also be concluded that the gauze fabrics knitted with coarser yarn can absorb more blood than finer yarn.

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