A Preliminary Study on the Design of C-Section Props

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ABSTRACT. A cesarean section (c-section) is a surgical procedure aimed to deliver a baby by opening the abdominal wall and uterus. Now, c-section is one of the choices that are often chosen by mothers when giving birth. The knowledge and skills of c-section are important in education that focuses on obstetrics and obstetrics, especially for prospective specialist doctors taking the title of Specialist in Obstetrics and Gynecology (SpOG). Residents are required to be able to understand the procedure of c-section both in theory and practice. To train and improve c-section skills, one of the methods used is to use c-section props. This study aims to design and manufacture c-section props that resemble actual conditions and can be used repeatedly. The cesarean section props consist of three main parts, namely the abdominal body, the uterus, and the synthetic skin layer of the abdomen. The product master uses 3D printer results with PLA filament material. The props are made of RTV-48 silicone rubber and Polyurethane Foam with a mold made of fiberglass composite using the Hand Lay-UP method. The c-section props produced can provide an overview of the general cesarean surgery procedure..

Keywords: props, c-section, silicone rubber

1. INTRODUCTION

Indonesia is an enormous archipelagic country with a population of more than 270 million people. This number continues to increase over time. The increase in population is inseparable from the birth process. There are several methods of giving birth commonly used, namely vaginal delivery and delivery by cesarean section (C-section). The term comes from the Latin, caedare which means to cut or slash [1]. In obstetrics, the term refers to a surgical procedure that aims to give birth to a baby by opening the walls of the mother's abdomen and uterus [2].

A c-section is often seen as a last resort to deliver a baby when a vaginal birth is not possible. But lately, more and more c-sections are being performed because there are many requests from mothers to deliver c-sections [3],[4].

C-section is usually performed when the development of labor is too slow or when the fetus seems to be in trouble, such as the mother experiencing vaginal bleeding, transverse position, the shape and size of the baby's body is large, or delivery with the mother's age is not young anymore or around the age of 35-40 years [5],[6].

In general, c-section is divided into two, namely elective (planned) and cito (immediate). A planned or elective c-section is a c-section that is scheduled with preparation and is performed on patients with non-emergency conditions, whilst cito surgery is a c-section performed with the aim of saving life in a patient in an emergency [7].

Knowledge of the c-section is important in education that focuses on obstetrics and childbirth, especially for prospective specialists (residents) taking the title of Specialist in Obstetrics and Gynecology (SpOG). Traditionally, c-section skills are taught on an apprenticeship model, where the resident first observes and then performs the procedure under the supervision of a more experienced senior physician [8]. Another method used for teaching clinical skills is to integrate educational strategies such as simulation-based training [9-11].

Some imported products of c-section props are already on the market, but the prices given are very expensive. Therefore, a domestically produced c-section is needed at a more affordable price.

This study aims to design and manufacture a c-section prop that has an anatomy close to the actual condition and can be used repeatedly by only replacing certain parts.

2. MATERIALS AND METHODS

2.1 Design Criteria

In designing the prototype of a c-section, there are two criteria that must be met, namely the must and want criteria. The design criteria are as follows:

1. Must criteria are criteria that must be met in the design and manufacture of c-section props. The criteria that must be met are:
   a. Able to provide an overview of the c-section process in general.
   b. Can be used repeatedly.
   c. Not easily broken.
   d. The dimensions of the props resemble the actual size.
2. The want criteria are the desired criteria for the product. The want criteria on the c-section props are:

a. Easy manufacturing process
b. Easy to use
c. Tools and materials are available easily
d. Easy to maintain
e. Light or not too heavy so easy to move

2.2 Concept of The Design

The concept of the design of the props is shown in Figure 1. In general, the props are divided into three parts, namely the body of the abdomen, uterus, and layers of skin to be dissected. Abdominal body will be done with the assembly process with the uterus. Before the c-section simulation process is carried out, the baby is inserted into the baby's womb and closed using a layer of synthetic abdominal skin to be dissected.

2.3 Design

The design is done with the help of Computer Aided Design (CAD) software as shown in Figure 2-4.
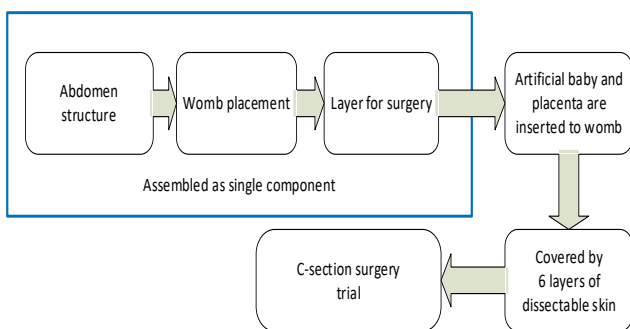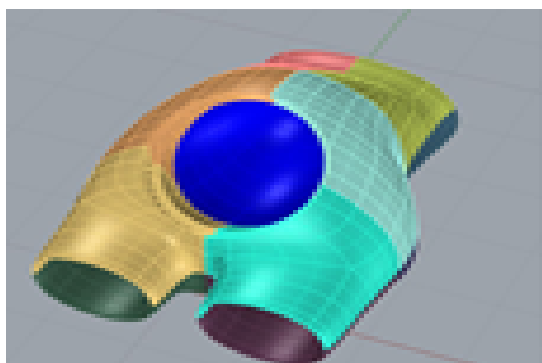

Figure 1. Tool Design Concept
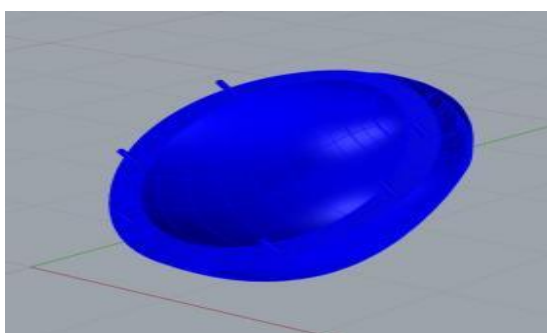

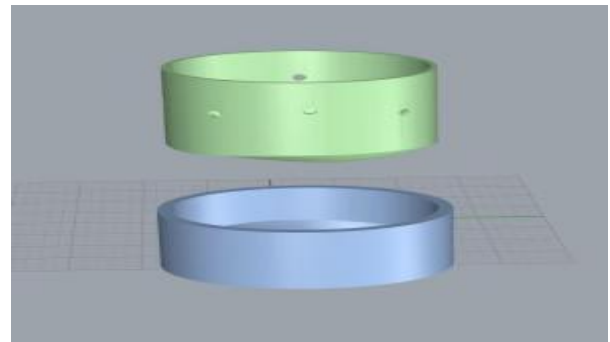Figure 2. Abdomen Body Design

Figure 3. Womb Design

Figure 4. Abdomen Layer Mold Design

3. RESULT AND DISCUSSION

C-section surgery props are made with anatomy resembling a pregnant woman's stomach with a uterus/ womb in the center. The materials used are Room Temperature Vulcanization (RTV) silicone rubber on the outside, and Polyurethane foam on the inside. The stages of making c-section props are as follows:

3.1 Manufacturing The Master

The body master of the abdomen was made using a 3D printer. Before printing with a 3D printer, segmentation is carried out into several parts in the design to match the printing dimensions of the 3D printer. Then each design segment is converted into a .stl file for the next G-code program to be created.

The next stage was the master printing process using PLA filament. The printing process used a nozzle temperature of 215°C according to the melting point of the PLA material, which is from a temperature of 190-230°C and a bed temperature of 70°C.

The results of the 3D printing master print were then connected to each part using glue. The master results can be seen in Figure 5.
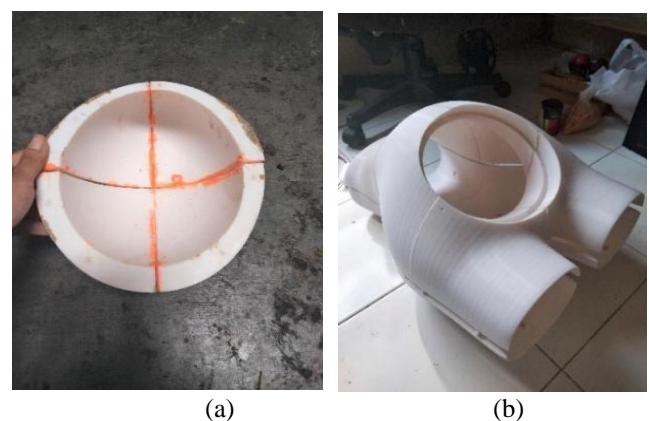

(a)   (b)

Figure 5. Master Result: (a) Abdomen Body, (b) Womb Body Master Result

3.2 Manufacturing The Mold

The manufacturing of the mold is divided into two, namely the manufacture of the abdominal body mold and the mold of the dissected synthetic abdominal skin layer. The mold was made using fiberglass fiber composite with the Hand Lay-Up method. The making was divided into 3 parts, namely (1) the upper abdominal body, (2) the lower abdominal body, and (3) the uterus. Before the resin and fiberglass application stage, the product master was smeared with mirror glaze (wax) so the composite mold can be removed from the master easily. The wax layer was left for 30 minutes to dry. To make the composite surface smooth, a mixture of gel coat and catalyst was applied in 3 layers. After applying the gel coat, matt fiberglass was glued together with the addition of resin. This process is carried out in layers, the layers are carried out in 3 layers with the aim of making the mold thick and strong.

(a)

(b)
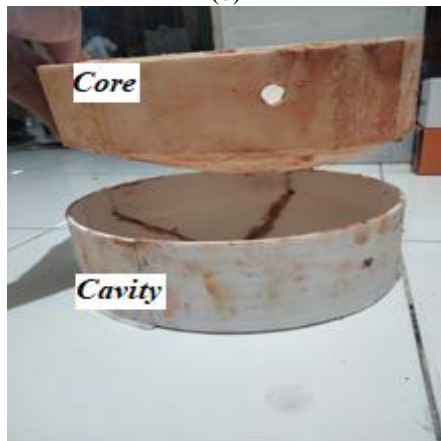
(c)

Figure 6. Surgical Props Mold (a) Abdomen Part, (b) Womb Part, and (c) Syntethic Abdomen Layer Part

The impression of the synthetic abdominal skin layer is divided into two components, namely the cavity and the core. The material used is PLA filament using a nozzle temperature of 215°C and a bed temperature of 70°C. The results of each print can be seen in Figure 6.

3.3 The Making of C-Section Props

The manufacture of the product was divided into two processes, namely the molding of the abdominal body product with silicone rubber and polyurethane foam materials and the manufacture of synthetic abdominal skin product using silicone rubber.

a. Printing Abdomen Body Product

The abdominal body was molded using RTV-48 silicone rubber with a catalyst composition of 4%. Silicone rubber was dyed to give a color that resembles human skin. The printing was done by pouring silicone rubber into each mold, then waiting for about 12 to 24 hours to ensure that the silicone rubber has hardened. The inner body of the abdomen uses polyurethane foam to save costs and make the props lighter. The final result of the unfinished abdominal body can be seen in Figure 7.

Figure 7. Product Body Result with Silicone

Figure 8. Imprinted SyntheticAbdomen Layer with RTV-48.

b. Manufacturing Synthetic Abdomen Layer Product

The process of printing the abdomen layer was done by using silicone rubber RTV-48 mixed with a catalyst and dye. The printing process was carried out using a printing system with layer-by-layer printing techniques. Each layer was waited for dry and coated with wax so that the top layer did not mix with the silicone in the bottom layer. The synthetic abdomen rubber layer consists of 6 layers with different thicknesses and colors. It was intended to show several layers in the process of cesarean surgery, such as skin, fat, fascia, muscle, peritoneum, uterus/uterus.

The results of the synthetic abdomen layer product with silicone material can be seen in Figure 8.

3.4 Testing The Props

The test was carried out by carrying out several steps, namely assembling the body of the stomach, uterus, and skin layer, then surgically removing the layer of the abdomen. In this study, the test was only carried out to see the results of the synthetic skin layer made and has not been tested by competent medical personnel to perform a c-section. From the results of the test carried out, the props still have shortcomings in the abdomen layer holder. The seat made was not strong enough to keep the synthetic abdominal skin layer in position during the sewing process on each synthetic leather layer. The tool can be used repeatedly by only replacing the synthetic abdominal skin that has been dissected and sutured. The experimental results of the tool can be seen in Figure 9.

(a)

(b)
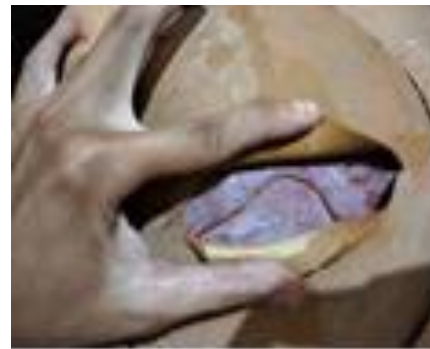
(c)

(d)

(e)

Figure 9. Prop Test Results: (a) artificial baby was inserted in the uterus, (b) synthetic skin layers were attached to the abdominal body, (c-d) synthetic skin layers were dissected layer by layer, (e) the process of removing artificial babies.

4. CONCLUSION

Based on the results of the research, it is found that the prototype of Caesarean section props has been successfully made using RTV-48 silicone rubber material and Polyurethane foam. The prototype of c-section props can be reused over and over again by replacing parts of the synthetic abdominal layer.

1. The synthetic abdomen layer was made in layers with a total of six layers that have different colors and thicknesses to describe the layer of the abdomen.

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