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TITLE:

Protocol of surgical indications for scar contracture release before childbirth: women with severe abdominal scars after burn injuries

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Abstract

It is difficult to determine if women with severe abdominal burn scar contractures can have uneventful pregnancies and births. There are few reports involving the relationship between severe abdominal scar contractures and pregnancy/childbirth. Furthermore, all of these reports are based on retrospective studies. The present study focused on women with severe abdominal burn scar contractures with desired fertility. We investigated whether or not normal childbirth is possible, the necessity of scar contracture release, and the delivery method. In addition, a protocol developed by our hospital was prospectively evaluated. Surgery was indicated in women with scars covering $\geq$ 75% of the total abdominal area. The scarred area in the upper abdomen, superior to the navel, was

considered particularly important. The protocol of this study serves merely as a reference, and future studies are needed with an increased number of cases.

Key Words: burn, severe abdominal scar contracture, childbirth, surgical indications

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Manuscript

Severe burn scar contracture in the abdominal region becomes problematic for women during pregnancy and childbirth. There have only been a few reports on the relationship between scar contractures and pregnancy/childbirth. It is often difficult to determine whether normal pregnancy and childbirth is possible. This study examined women with severe abdominal scar contractures due to past burn injuries who wanted to become pregnant and have children. It investigated whether or not normal pregnancy and childbirth were possible, the

necessity of scar contracture release, and the delivery method. In addition, a protocol developed by our hospital was prospectively evaluated.

Materials

In the past 15 years, our institution has seen 12 patients who had undergone abdominal skin grafting or surgical resection of scars after burn injuries, who had severe scars covering 50% or more (mean 64%) of the total abdominal area, and who could become pregnant. Of these 12 patients, 10 patients were able to have normal childbirth without a scar release surgery and there were 8 patients with Cesarean section and 2 patients with vaginal delivery. The remaining 2 patients had undergone abdominal scar contracture release for pregnancy and childbirth. In one case, pregnancy and delivery by Cesarean section was

possible. Another case had no previous pregnancy, but she (29-year old) had undergone abdominal scar contracture release for the purpose of childbirth.

Our protocol (Fig. 1)

Surgery should be performed based on each case; however, with respect to surgical indications, we sometimes hesitated about the judgment. For one patient who had undergone scar contracture release surgery, we consulted the obstetricians and gynecologists to determine the treatment plan and created our protocol regarding childbirth in women with severe abdominal burn scars. Surgical indication is considered in reference to the following protocol. If patients have a full-thickness scar covering less than 50% of the total abdominal area, surgery is generally unnecessary. If patients have a scar covering 50-75% of the

total abdominal area, whether surgery is performed depends on the case. In such patients, the evaluation is performed by dividing the scars into those inferior to the umbilicus (lower abdomen) and those superior to the umbilicus (upper abdomen). Scar release surgery is indicated in patients with a supraumbilical scar covering 50% or more of the abdominal wall (i.e., scar covering the entire upper abdomen). If patients have scars covering 75% or more of the total abdominal area, scar release surgery is always performed.

For the delivery method, since the fetus needs to descend for vaginal delivery, sufficient extensibility is required in the infraumbilical (lower abdominal) skin. In addition, an open leg position is necessary. If the scars cover 50% or more of the infraumbilical skin (i.e., more than half of the lower abdomen), Cesarean section is

desirable. However, if patients strongly desire vaginal delivery and can be in a lithotomy position, we also consider surgical treatment.

If patients are already pregnant and surgery is indicated based on the above protocol, generally they are monitored with regular follow-up. However, the policy is to also consider surgery after thorough consultation with the obstetricians, gynecologists, and patients themselves, after examination of effects of general anesthesia and scar release surgery on the fetus and patients, and after examination on the continuation of pregnancy and the difficulty of delivery. This protocol is indicated for patients with mature scars, minimally two years after surgery for fresh burn injury.

Representative cases

Two cases are presented below in which surgery and delivery methods were determined according to the protocol.

Case 1: The patient was a 33-year-old woman who had fallen into a sunken hearth when she was a young child. She suffered burn injuries to approximately 25% of her body, from the area below the umbilicus to the lower abdomen and thighs. The patient had previously undergone 3 surgeries but severe scar contracture remained in the areas (Fig. 2a). She married and became pregnant, but there was a concern of difficult delivery due to scar contracture in the lower abdomen. Thus, the department of obstetrics and gynecology referred her to our department. The scar covered approximately 50% of the total abdominal area, and almost the entire infraumbilical area (approximately 90%) was covered with scar tissue. However, scar

contracture was confined mostly to the lower abdomen, and minimal scarring was observed above the umbilicus. Since the upper abdominal skin had sufficient extensibility, it was determined that the patient could have safe delivery (Figs. 2b and c). Although there were severe scar contractures in the thighs, the patient was able to be in an open leg position. However, there was severe contracture of the infraumbilical skin, and vaginal delivery was determined to be not possible. Thus, a vertical incision was made from 2 cm below the umbilicus, and delivery was by Cesarean section. Delivery was uneventful and a baby girl weighing 3128 g was safely delivered. In addition, the mother and baby were both healthy. Two years later, this patient delivered her second child (baby girl) weighing 2786 g by the same method.

Case 2: The patient was a 29-year-old woman who sustained burn injuries when her clothes caught fire at the age of one year. She suffered burn injuries to 70% of her body, from the axillae to the chest, back, and thighs. The patient had undergone 5-6 surgeries for skin grafting. She presented to the hospital for consultation because she wanted to become pregnant and have a child. There was severe scarring from the axillae to the chest, back, and thighs. The patient constantly felt a sense of pressure in the thoracoabdominal region which restricted her food intake per meal and limited her ability to perform intensive exercise. Scar tissue covered 80% of the entire abdomen. The supraumbilical area in the upper abdomen consisted of 100% inextensible scar tissue (Figs. 3a and b). We determined the risk in pregnancy based on the protocol and planned to perform prepregnancy scar release and plastic

surgery using skin grafts. The infraumbilical skin had satisfactory extensibility, and the patient was able to be in an open leg position. Thus, we thought that vaginal delivery was possible. In surgery, scar contracture release was performed near the periumbilical area. Approximately 800 cm^2 skin defect developed. Therefore, split-thickness skin grafts harvested from bilateral thighs were used (Fig. 3c). Currently at 3 years after surgery, extensibility of the periumbilical skin has improved to a level where the skin can be pinched, and the patient can become pregnant and have childbirth (Fig. 3d).

Discussion

When young women have severe burn scar contractures in the abdominal wall, there is a concern that they might become a hindrance to pregnancy and childbirth.

Only a small number of reports have been published on the relationship of severe abdominal scar contracture with pregnancy and childbirth.

There have been reports on pregnancy and childbirth in patients with abdominal scars after burn injuries. Rai et al. (1) examined 21 such patients and 42 children, and McCauley et al. (2) examined 7 patients and 14 children. These patients had uneventful pregnancies and childbirths without scar release surgery. Kitzmiller et al. (3) examined 19 patients who had undergone skin grafting or resection of at least 50% of the abdominal wall because of burn scars. They had uneventful delivery either vaginally or by Cesarean section and gave birth to 31 children. Based on their experience, they found no evidence showing that abdominal scars hindered childbirth. This finding was

consistent with the opinion that abdominal scar contracture release is unnecessary during pregnancy.

Haeseker et al. (4) reported that patient had premature birth when burn scar release was performed in the abdomen during the second trimester, resulting in death of her child. Widgerow et al. (5) reported on childbirth in two patients with severe abdominal scar contracture. They stated that scars prevented the expansion of the uterus and performed scar release and split-thickness skin grafting in the first trimester. These 2 patients had uneventful vaginal delivery. Takeda et al. recently performed expansion abdominoplasty, consisting of zigzag incisions in the fascia to release the contracture and a split-thickness skin graft. The patient was at 20 weeks of pregnancy and had a severe abdominal scar. She gave uneventful birth via cesarean operation at 36 weeks of pregnancy (6).

All these previous reports have been on retrospective clinical studies or case reports. The present study consulted the obstetricians and gynecologists and examined what type of burn scar contractures in the abdominal area would hinder pregnancy and delivery. Subsequently, our own protocol was created and evaluated prospectively. Whether abdominal scar contractures can hinder pregnancy and delivery will depend on the site and extent of scarring. Extensibility of abdominal skin is important in pregnancy and delivery. If one assumes that flat skin can stretch to cover a hemisphere, the area is πr^2 before pregnancy and $4\pi r^2/2=2\pi r^2$ during pregnancy (Fig. 4a). That is, the normal skin can stretch to approximately twice the area it had before pregnancy. If the skin does not stretch at all, the skin surrounding that area needs to compensate and stretch (Fig. 4b). Therefore, the extensibility needed from the

surrounding normal tissue changes greatly depending on the percentage of inextensible scar. When the percentage of inextensible scar exceeds 50%, normal tissue needs to stretch about 4 times its original size. If the percentage exceeds 70%, the skin needs to stretch more than 6 times its original size. Thus, there will be a large burden on the skin and the fetus (Fig. 5). These numbers are calculated with the assumption that the scarred skin does not stretch at all. Clark et al. (7) examined the properties of normal skin and scarred skin after burn injury. They studied the relationship between strength and extensibility and found that severely scarred skin has a certain level of extensibility, although the level depended on the degree of scarring. In addition, it has been reported that scarred skin after burn injury can be gradually stretched, just as in abdominal skin in pregnancy,

and that the stretchability is higher than when the skin is stretched in a single stage (8).

Thus, one can expect at least slight stretching of scarred skin during pregnancy. In our protocol, the indication for scar release surgery is scars covering a large area of at least 75% of the total abdominal region.

The present study assumed that the abdominal region expands in a hemispheric manner with the umbilicus as its center during pregnancy. The abdomen was divided into the areas above the umbilicus and below the umbilicus. The percentage of the scarred area in the upper abdomen, superior to the navel, was considered particularly important. The uterus is located almost in the center of the lower abdomen, posterior to the pubic bone, and inferior to the umbilicus. Thus, when the uterus expands during pregnancy, the skin more inferior to the umbilicus mainly

expands and stretches under normal circumstances. If stretching of the abdominal skin is inhibited by scarring after burn injury, the uterus is speculated to move into the upper abdomen where the diaphragm can move superior because the intrapelvic space is limited in the lower abdomen. If there is very severe scarring in the upper abdomen above the umbilicus, respiratory difficulty can result. In such cases, the uterus might not be able to expand sufficiently. Thus, we placed great importance on the scarring in the upper abdomen and believed that such scars should be released before pregnancy. In the actual surgery, split-thickness skin grafting is normally indicated after scar release surgery. However, the problem of postoperative contracture cannot be avoided. Kakagia et al. performed a two-stage procedure using artificial dermal template and thin split-thickness skin graft, enabling full-term pregnancy

(9). Although this procedure requires two surgeries and a longer treatment period, one should consider the use of artificial dermis.

The fetus must descend in the uterus for vaginal delivery. Therefore, the infraumbilical (lower abdominal) skin must stretch sufficiently and the patients must be able to be in an open leg position. The present study considered the percentage of infraumbilical scar to be important and determined that Cesarean section was desirable if the scars covered at least 50% of the lower abdominal skin.

In this report, we described the protocol for surgical treatment of women who had abdominal scar contractures after burn injuries and who wanted to become pregnant and have children. This protocol was not based on an abundance of experience and rigorous scientific evidence. Therefore, the protocol serves only as a reference, and

surgery should be performed based on the case. Collective experiences from multiple burn centers or national burn associations are needed in the future; specifically, data about pregnancy being complicated by burn scars and the incidence of these problems reduced by selective surgical release is needed.

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Legends

Fig. 1: Our protocol for childbirth in women who have severe abdominal scars after burn injuries

Fig. 2: Case 1

(a) Initial examination: frontal view

(b) Frontal view of the abdominal region at 39 weeks of pregnancy (before Cesarean section)

(c) Lateral view of the abdominal region at 39 weeks of pregnancy (before Cesarean section)

Fig. 3: Case 2

(a) Initial examination: frontal view

(b) Initial examination: lateral view

(c) Surgical findings: split-thickness skin grafts harvested from bilateral thighs were used.

(d) State 3 years after surgery

Fig. 4:

(a) Extensibility of abdominal skin required during pregnancy

(b) Extensibility of the scarred skin

Fig. 5: Percentage of scarred area and required

Fig.1

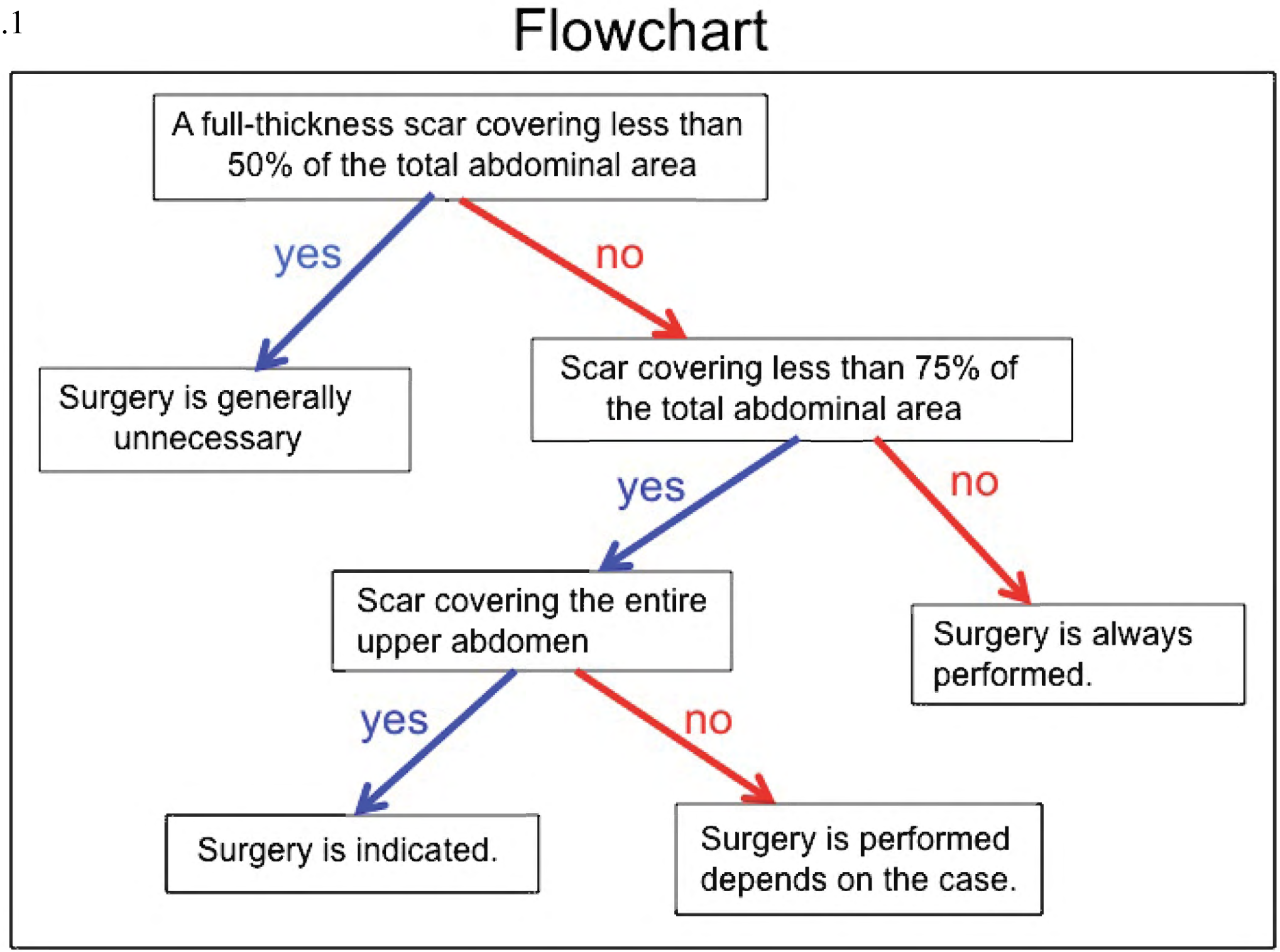

Flowchart
A full-thickness scar covering less than 50% of the total abdominal area
yes
no
Surgery is generally unnecessary
Scar covering less than 75% of the total abdominal area
yes
no
Scar covering the entire upper abdomen
Surgery is always performed.
yes
no
Surgery is indicated.
Surgery is performed depends on the case.

Fig.2(a)

Fig.2(b)

Fig.2(c)

Fig.3(a)

Fig.3(b)

Fig.3(c)

Fig.3(d)

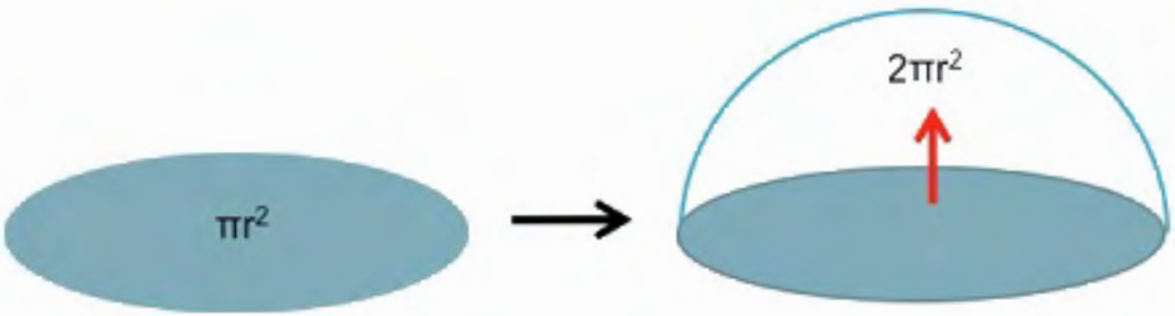


Fig.4(a)

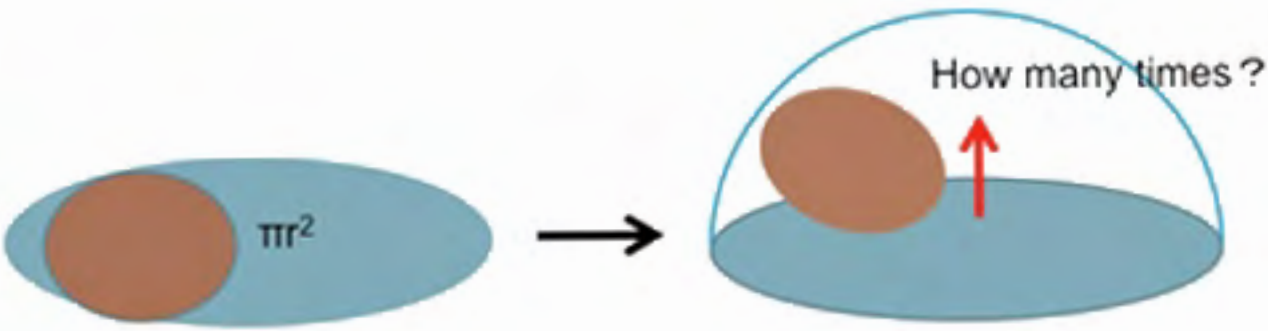
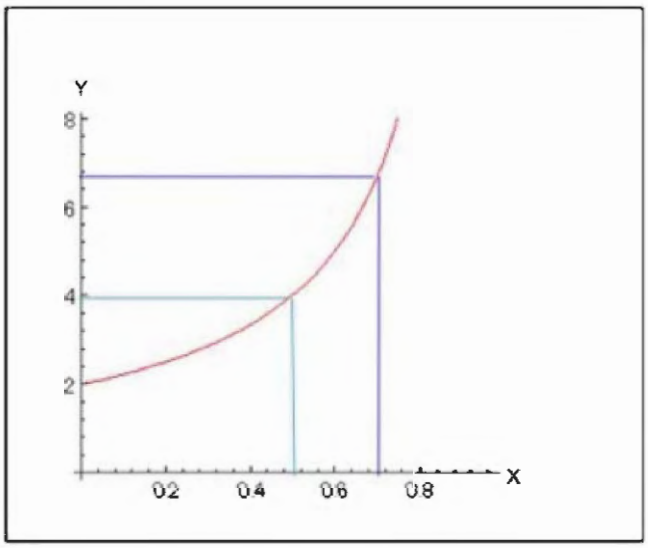


Fig.4(b)



X: Rate of the scar
Y: Extension rate

$Y=2/(1-X)$

Fig.5