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An experimental study of delay of flow-through venous flaps

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SUMMARY. **A delay procedure was performed in flow-through venous flaps made in rabbits' ears. Compared with undelayed venous flaps, the delayed flaps at 7, 14 and 21 days after delay showed a distinct increase of survival area. This effect increased with the delay period.**

A venous flap is an unusual flap which is nourished by venous perfusion and the survival mechanism is not yet clearly explained.

There are different types of venous flaps-flow-through, arterialised and island types (Fig. 1).

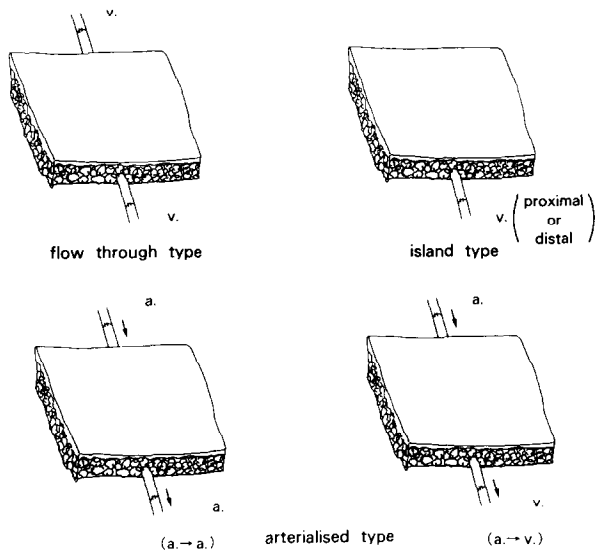


Fig. 1

Figure 1—Different types of venous flaps-flow-through, arterialised and island.

We present an experimental study to determine whether increase of surviving flap area could be achieved by a delay procedure in a flow-through venous flap.

Materials and methods

Twenty-five 2.5 kg rabbits (50 ears) were used in this study. They were anaesthetised with Pentobarbital (30 mg/kg) intravenously after ether inhalation.

The venous flap was designed on the rabbits' ears adjacent to a vein crossing the base. The flaps included the full thickness of the dorsal and ventral skin and cartilage, to avoid damage to the vascular network around the perichondrium (Fig. 2A).

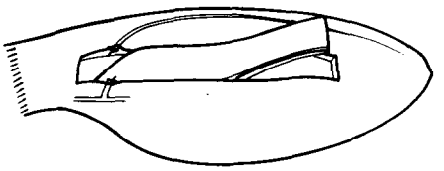
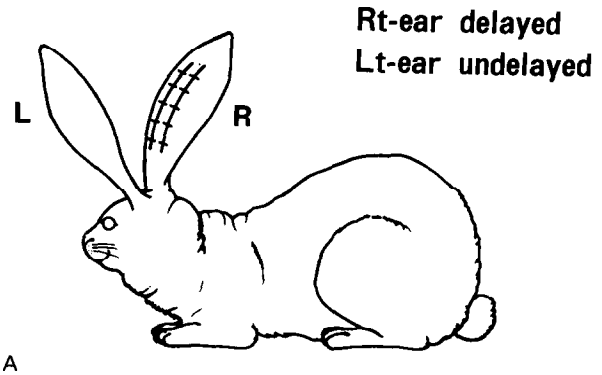
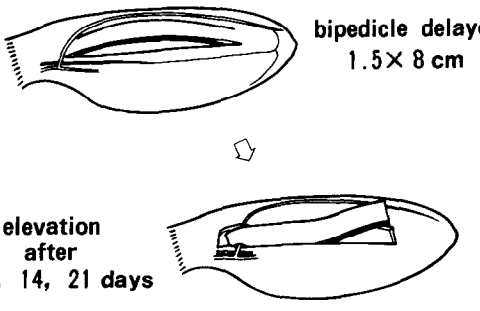


Fig. 3

Figure 3—Control group (n = 5) As a control, the vein in the flap base is ligated.



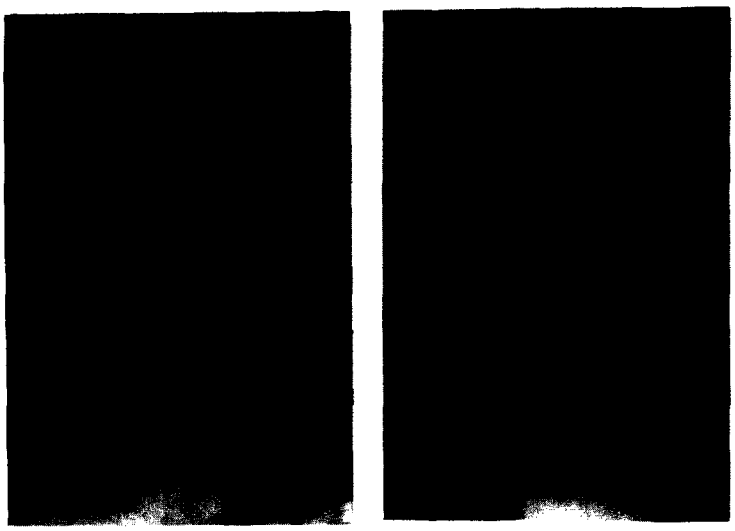
A



B

Fig. 2

Figure 2—(A, B) Full thickness bipedicle flap (1.5 × 8 cm) elevated in the right ear, with a vein crossing the proximal end. After 2, 7, 14 and 21 days of delay, a flow-through venous flap is elevated, but no longitudinal vein is planned in the flap. The left ear is not delayed.



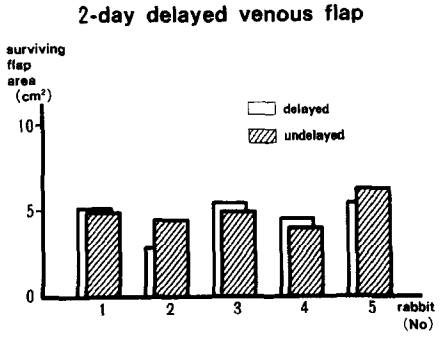
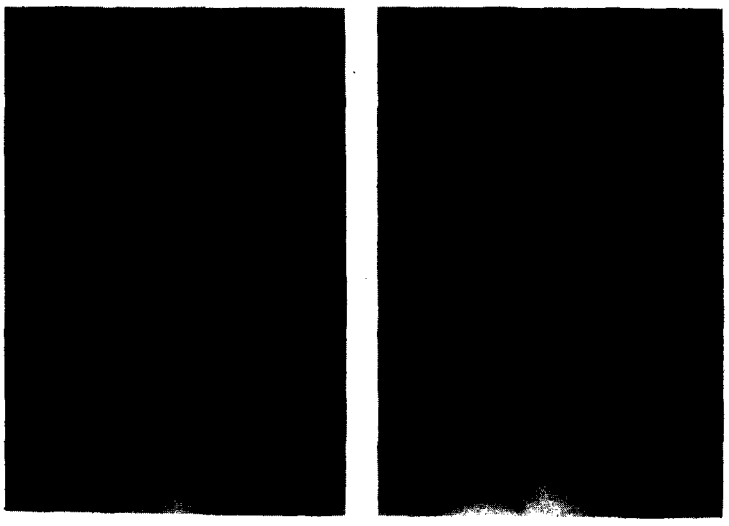


Fig. 4



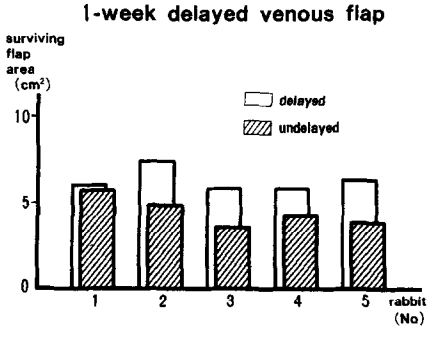
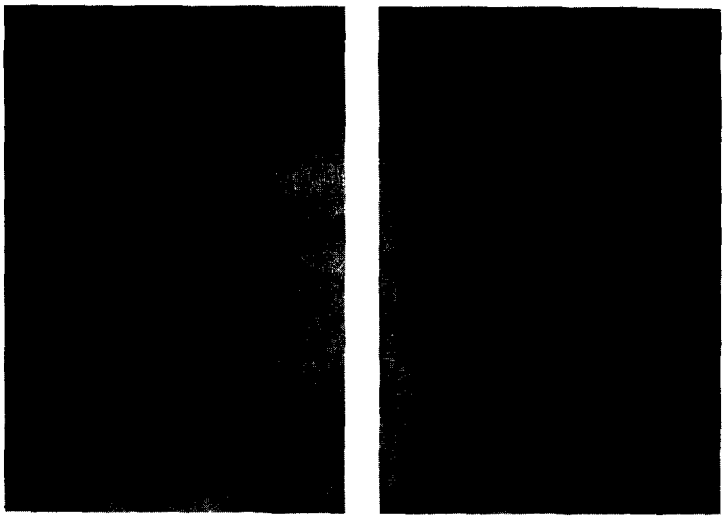
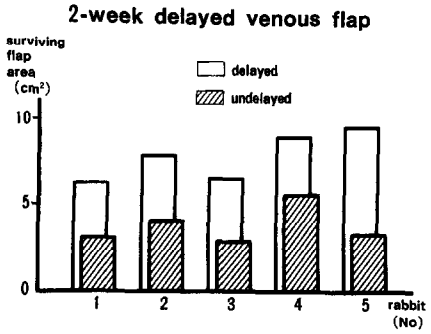


Fig. 5

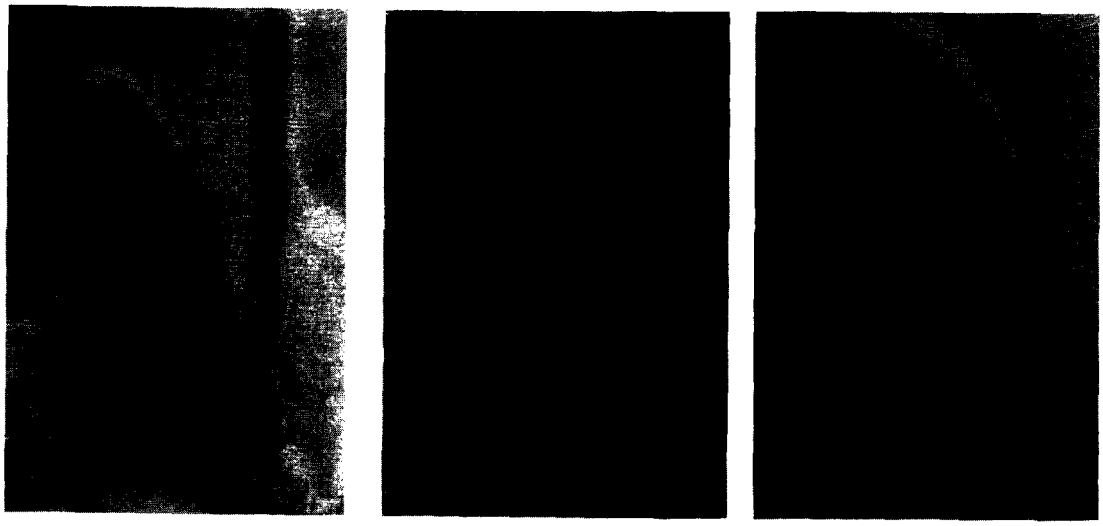
Figure 4—2 days of delay. (A) The left undelayed venous flap (B) The right delayed venous flap (C) Comparison between survival areas of delayed flaps and ones of undelayed flaps. There was no statistically significant difference. **Figure 5**—7 days of delay. (A) The left undelayed venous flap (B) The right delayed venous flap (C) There was a statistically significant difference ($p = 0.05$).

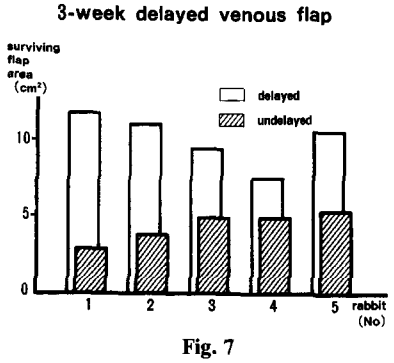




C

Fig. 6





D

Fig. 7

Figure 6—14 days of delay (A) The left undelayed venous flap (B) The right delayed venous flap (C) There was a statistically significant difference ($p = 0.01$). **Figure 7**—21 days of delay. (A) The left undelayed venous flap (B) The right delayed venous flap (C) The ventral side of the right delayed venous flap (D) There was a statistically significant difference ($p = 0.01$).

Initially a full thickness bipedicle flap 1.5 × 8 cm was raised in the right ear with the vein crossing the base. Any longitudinal branches were deliberately avoided in raising the flap.

After 2, 7, 14, and 21 days of delay (5 rabbits in each delay group), an island flow-through venous flap measuring 1.5 × 8 cm was created by cutting through all remaining tissue except the flow-through vein across the base (Fig. 2B). Adjacent to the vein, this was done under the microscope. The flap was sutured back with 5–0 nylon.

Simultaneously in the left undelayed ear, the same sized island flow-through venous flap was done similarly with preservation of the flow-through vein. After 7 more days the animals were anaesthetised and survival areas of the dorsal side were traced onto tracing papers and then these measured with a polar planimeter. Survival areas between delayed and undelayed flaps were compared statistically by Student's t-test.

As a control, flaps in which the pedicle vein was ligated were used in 5 rabbits. In the right ear the vein was ligated after the seven days of delay. In the left ear it was done without delay (Fig. 3). After 7 more days the flaps were photographed and the survival areas measured.

In a further study on 5 rabbits, a longitudinal venous branch was deliberately included in the right bipedicled flap at the time of delay (Figs 11, 12).

Results

2 days delay. There was no significant difference (Fig. 4).

7 days delay. There was a significant difference ($p = 0.05$) (Fig. 5).

14 days delay. There was a significant difference ($p = 0.01$) (Fig. 6).

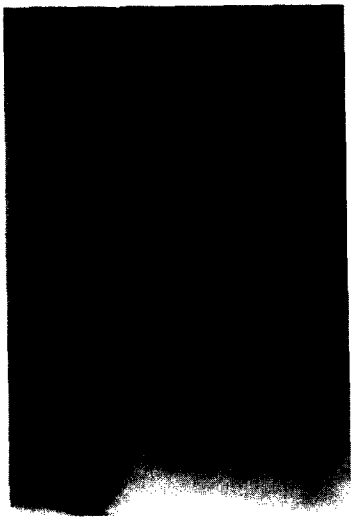


Fig. 8

Figure 8—Control group. All flaps totally necrosed regardless of any preliminary delay procedure.

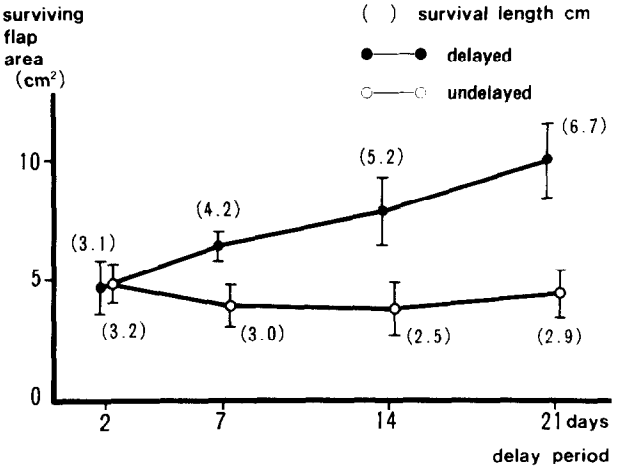


Fig. 9

Figure 9—Survival flap area increased in proportion to duration of delay. Survival length (cm) = survival flap area (cm^2) ÷ 1.5 cm (width of flap).

21 days delay. There was a significant difference ($p = 0.01$) (Fig. 7).

Control group. All flaps totally necrosed, regardless of any previous delay procedure (Fig. 8).

The survival area was found to increase with the duration of delay (Fig. 9), with significant statistical differences between the survival area of groups with differing periods of delay.

Discussion

Our findings here differ from a random pattern flap delayed by a bipedicled incision in which survival length reaches a maximum by one or two weeks of delay (Myers and Cherry, 1967; Suzuki *et al.*, 1986).

A flap which was delayed for three weeks by a bipedicled incision is shown in Figure 10. An enlarged and tortuous vessel is shown in the flap. This vessel was consistent, always a vein, and it appeared 2 or 3 weeks after a bipedicle incision even though a longitudinal vein was not visible in the area when the flap was initially planned. Therefore it appears that longitudinal re-orientation and increase in the size of venous vessels occurred and this may have contributed to the increase in survival length. If a flap was designed to contain a venous branch, the survival length was increased in spite of a short duration of delay (Fig. 11). In the extra group of five flaps this fact was noticed. In spite of 14 days delay, their survival length was nearly as long as one of 21 days delayed flaps which contained no venous branch (Fig. 12).

Further investigation is needed, but our conclusions here show that the flow-through venous flap can be lengthened by a preliminary delay procedure.

With even longer periods of delay, it is possible even longer flaps could be created due to longitudinal re-orientation, though this effect may be limited by the venous blood pressure being lower than arterial blood pressure.

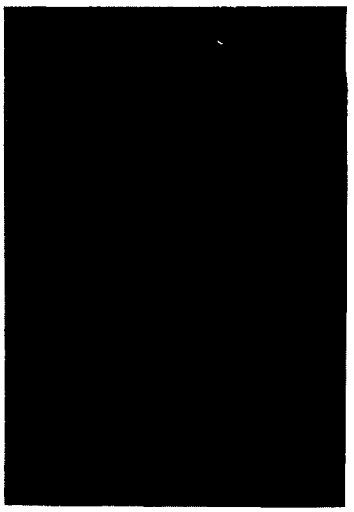
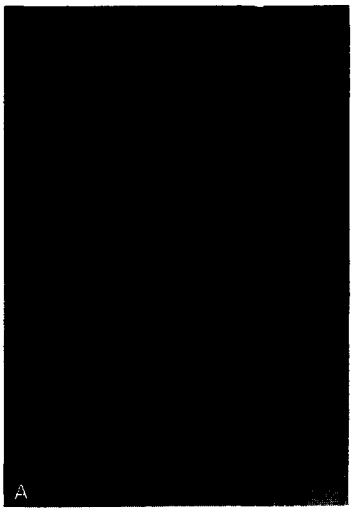


Fig. 10



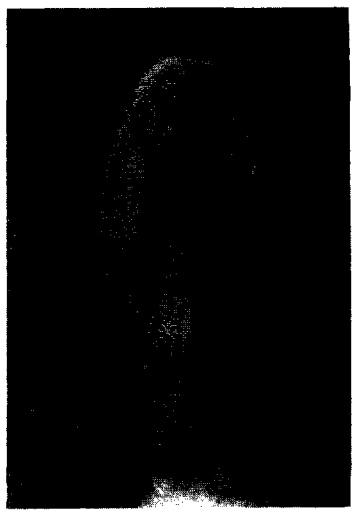


Fig. 11

Figure 10—The ear which was delayed three weeks after a bipedicle incision. An enlarged and tortuous vessel is seen in the flap. **Figure 11**—(A) A longitudinal vein designed to be contained in the flap. (B) The survival flap area increased in spite of only two weeks delay.

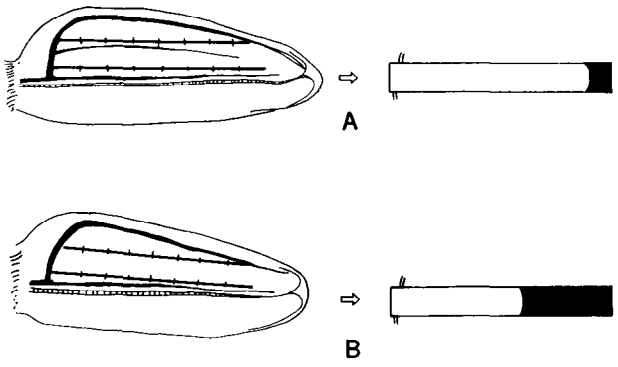


Fig 12

Figure 12—With 14 days delay, survival length of flaps with a longitudinal vein in them was nearly as long as of 21 days delayed flaps which contained no such vein. (A) With a longitudinal vein within the flap when raised. (B) With no such longitudinal vein.

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