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INGUINAL FLAP TRANSPLANTED TO THE NECK

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Summary

Objective. The inguinal flap is a fascio-cutaneous, pedicled or free flap. It receives its blood supply from the epigastric artery, a branch of the femoral artery, and its venous return is via the epigastric vein, which flows into the femoral vein. The primary endpoint was the success of the double arteriovenous anastomosis, with patency test at the end of the procedure. The secondary endpoint was operative time, which assessed the learning curve for dissection and anastomosis times.

Methods. This prospective, single-center, single-operator study was carried out at the microsurgery laboratory of the École de chirurgie du Fer à Moulin from February to May 2023, using an experimental series of ten albino rats. Ten albino rats, male or female, weighing between 200 and 350 grams approximately will be used for this thesis. The animals were anesthetized intramuscularly with 10 mL of Ketamine (50mg/mL) and 1.5 mL of Chlorpromazine (5 mg/mL), effective for around 3 hours. The inguinal and cervical regions will have been trimmed pre-operatively.

Results. Both anastomoses were patent in 3 out of 10 rats (30% of cases). The arterial anastomosis alone was patent in 3 rats (#3, #6, #10), and the venous anastomosis alone was patent in 1 rat (#7). For 3 rats, both anastomoses were not permeable. Overall operating time was reduced from 202 minutes to 129 minutes in the final sessions. In 10 sessions, this represents a 36% reduction in surgical time. More specifically, dissection time fell from 116 minutes to 76 minutes. Microsurgery time fell from 67 minutes to 48 minutes. In 10 sessions, 40 minutes of dissection time and 19 minutes of microsurgery time were saved.

Conclusions. This scientific work has highlighted the demanding nature of microsurgical practice, which requires ongoing training in a constant quest for excellence. It's a long journey, in which regular practice and absolute rigor enable the gradual acquisition of skills.

Key words: microsurgical anastomoses, arteriovenous anastomosis, inguinal flap, epigastric vessels, femoral artery, carotid artery

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INTRODUCTION

It is widely accepted that learning microsurgical techniques is now an integral part of modern training for future surgeons, whatever their specialty. It has been shown that laboratory work is one of the fundamental pillars of training, enabling the acquisition of microsurgical dexterity [1,2].

As I'm keen to improve my surgical skills and intend to specialize in hand surgery, acquiring these techniques is essential for me to better understand my future practice, perfect my knowledge and gain in self-confidence. It will also enable me to work on my introspection so as to control my emotions, improve my patience and strive for perfection [3-5].

The technical nature, rigor and learning difficulties of microsurgery make its practice very demanding, requiring a great deal of humility on the part of the surgeon, as many authors have stressed [6-9].

My choice of practical technique for this thesis was the inguinal flap transplanted to the neck, as it enables two dissections (inguinal fossa and neck) and two microsurgical anastomoses (arterial and venous termino-lateral) to be performed in a single session; all this with a significant time requirement due to the ischemic risk of the flap.

As a reminder, the inguinal flap is a fascio-cutaneous, pedicled or free flap. It receives its blood supply from the epigastric artery, a branch of the femoral artery, and its venous return is via the epigastric vein, which flows into the femoral vein.

MATERIALS AND METHODS

Experimental protocol

Ten albino rats, male or female, weighing between 200 and 350 grams approximately will be used for this thesis. The animals were anesthetized intramuscularly with 10 mL of Ketamine (50 mg/mL) and 1.5 mL of Chlorpromazine (5 mg/mL), effective for around 3 hours.

The inguinal and cervical regions will have been trimmed pre-operatively.

This prospective, single-center, single-operator study was carried out at the microsurgery laboratory of the École de chirurgie du Fer à Moulin from February to May 2023, using an experimental series of ten albino rats.

The primary endpoint was the success of the double arteriovenous anastomosis, with patency test at the end of the procedure.

The secondary endpoint was operative time, which assessed the learning curve for dissection and anastomosis times.

Surgical technique

Set-up

The animal is positioned supine, with the head to the left of the operator and the hind legs stretched out. The 4 limbs are held by adhesive strips on the operating table (Fig. 1).

The operator must pay close attention to the rat throughout the procedure, ensuring good ventilation andeffective anesthesia.

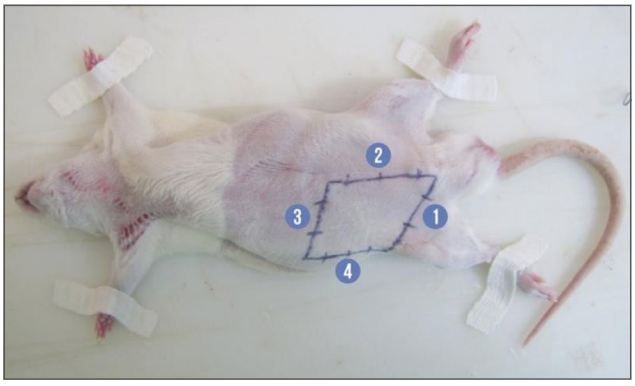

Figure 1. Installation of the rat and skin limits of the flap paddle.

Lifting the right inguinal flap

A quadrilateral skin paddle is drawn (Fig. 1).

The first incision corresponds to the right inguinal approach, 1 cm below the inguinal fossa; the femoral and epigastric vessels are checked.

The second incision runs parallel to the midline, approximately 0.5 cm outwards, and rises to a height of 4 cm.

The third incision is parallel to the inguinal incision.

The fasciocutaneous paddle is peeled off from the inside outwards, with macroscopic control of the epigastric vessels, and the fourth incision is made.

The flap is placed on a moist compress, ensuring that the vessels are never put under tension or twisted, which could compromise the viability of the flap.

Dissection of femoral vessels

Under microscope: x1 magnification

First, the innominate artery and vein are ligated together with 9/0 and then sectioned. The femoral artery and vein are then dissected, starting a little below the origin of the epigastric vessels and working up to the crural arch. The crural nerve is respected and reclined. Arterial and venous collaterals are ligated with 9/0 and sectioned.

A double ligation of the femoral artery and vein is performed just downstream of the epigastric vessels without sectioning (Fig. 2).

The epigastric vessels are very fragile, and it is essential not to dissect them in order to avoid spasm.

Neck preparation

Under microscope: x1 magnification

The approach consists of a shoulder-to-shoulder incision, followed by reclination of the salivary glands and lymph nodes towards the muzzle using a retractor.

We begin by dissecting the right external jugular vein from the pectoralis major to the cephalic trifurcation.

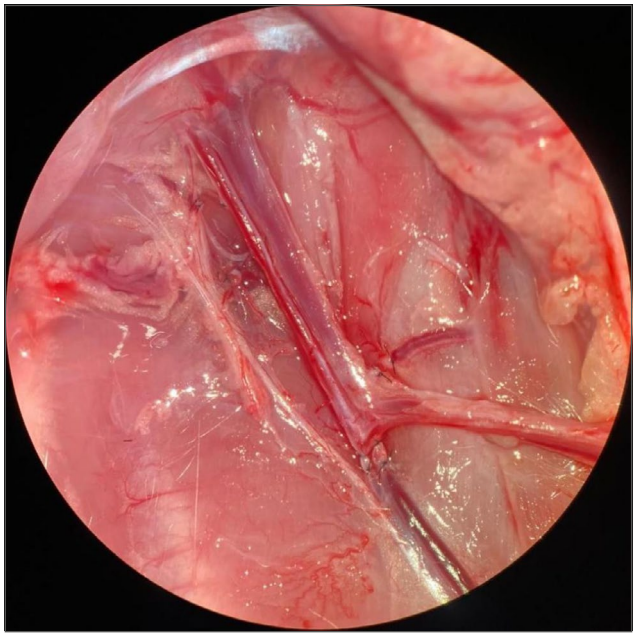

Figure 2. Prepared femoral vessels (microscopic view at x1 magnification).

The collaterals can be electrocoagulated.
Next, the hyoid muscle is cleaved and held in place by a retractor to allow exposure of the lateralaspect of the trachea and external carotid artery. The right carotid artery is easily dissected.
A yellow plasticized drape is placed under the carotid artery, and the hyoid retractor removed. The double GILBERT clamp is positioned opposite the operator, enabling arteriotomy perpendicular to the vessel axis using Gilbert scissors at high magnification x 1.6 or even x 2.5.
The carotid lumen is thoroughly rinsed.

Flap transfer

The first step consists of a common double 9/0 ligation of the femoral artery and vein below the cruralarch, followed by a simple IKUTA clamp on the femoral vessels upstream of the epigastric vessels (never on the epigastric vessels!).
The upstream artery and vein are then sectioned, rinsed abundantly and sectioned distally between the two ligatures placed below the epigastric vessels.
The flap is now free. It is placed on a moist compress on the animal's thorax, taking care not to twist the vessels.

Microsurgical anastomoses

Under microscope: magnification x2.5

We begin with the termino-lateral anastomosis of the femoral artery and the carotid artery, in order to limit the flap's ischemia time.
The symmetrical bi-angulation method is used, with 6 stitches of 11/0 starting with the corner stitches at 3 o'clock and 9 o'clock, then the flap is turned over to create the posterior aspect.
The single clamp is removed, then the double GILBERT clamp is unclamped from distal to proximal.
The patency test is positive if there is venous return in the femoral vein and active bleeding at the edges of the flap.
We now turn our attention to the termino-lateral anastomosis of the femoral vein and the external jugular vein.
A yellow plasticized drape is placed under the jugular vein, the single clamp is placed over the femoral vein, while the double GILBERT clamp is positioned towards the operator, enabling a venotomy to be performed perpendicular to the vessel axis.
After abundant rinsing, microsurgical sutures are started using the symmetrical bi-angulation method with 6 stitches of 11/0.
The single clamp is removed, followed by the double GILBERT clamp from distal to proximal (Fig. 3), and the patency test is performed.

RESULTS

Ten albino rats were included in this study, 4 females and 6 males; their weight ranged from 200 to 330 grams with an average weight of 258 grams.
10 flap sessions were performed.

Primary endpoint

Both anastomoses were patent in 3 out of 10 rats (30% of cases) (Fig. 4).
The arterial anastomosis alone was patent in 3 rats (#3, #6, #10), and the venous anastomosis alone was patent in 1 rat (#7). For 3 rats, both anastomoses were not permeable.

Secondary endpoint

Overall operating time was reduced from 202 minutes to 129 minutes in the final sessions. In 10 sessions, this represents a 36% reduction in surgical time.
More specifically, dissection time (Fig. 5) fell from 116 minutes to 76 minutes. Microsurgery time (Fig. 6) fell from 67 minutes to 48 minutes. In 10 sessions, 40 minutes of dissection time and 19 minutes of microsurgery time were saved.
1 rat was kept for 30 days (Figs. 7-9).
1 to 2 threads of 9/0 and 1 to 2 threads of 11/0 were used per procedure.
Microscopic analysis of the anastomoses by the trainers highlighted the following possible causes of failure:

- incorrect stitch distribution, most often due to incorrect positioning of one of the corner stitches: rat n°1 and 4;

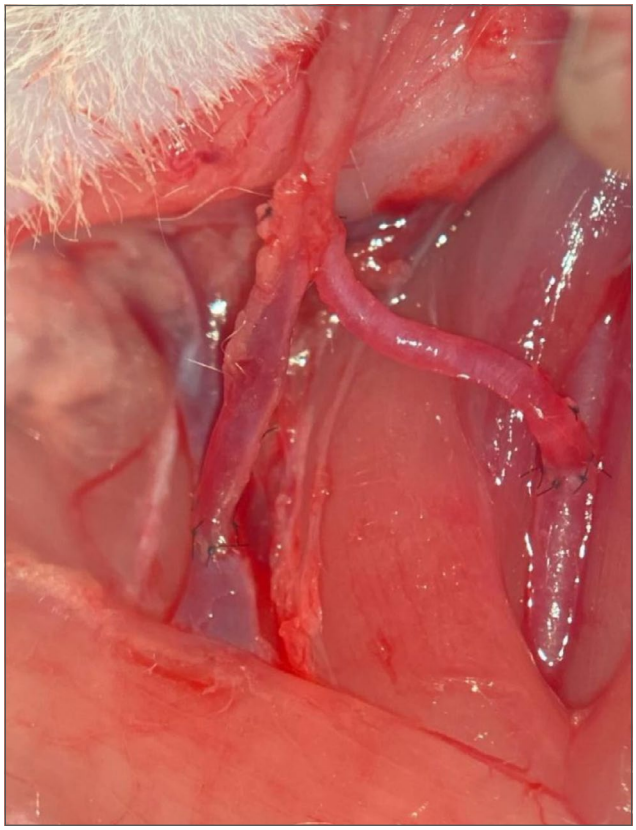

Figure 3. Final macroscopic appearance of the double arterial and venous terminal-lateral anastomosis.

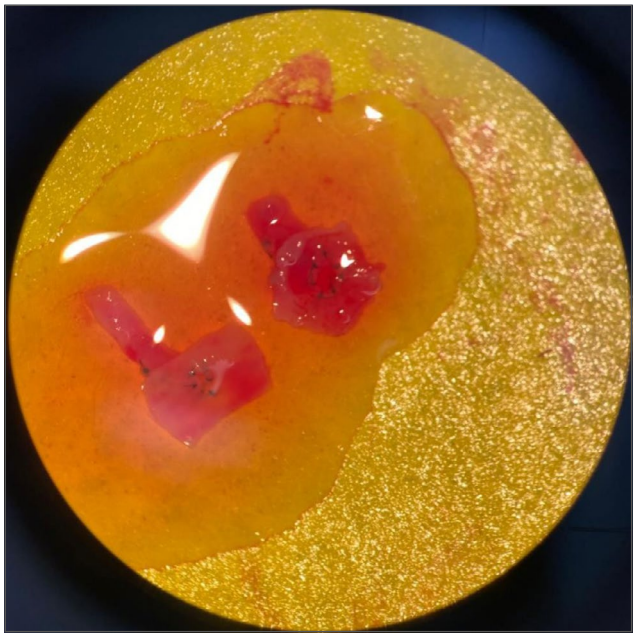

Figure 4. Intra-luminal microscopic view (x 2.5 magnification) of the termino-lateral anastomoses of the montage (left artery, right vein). Green circle = successful double anastomosis.

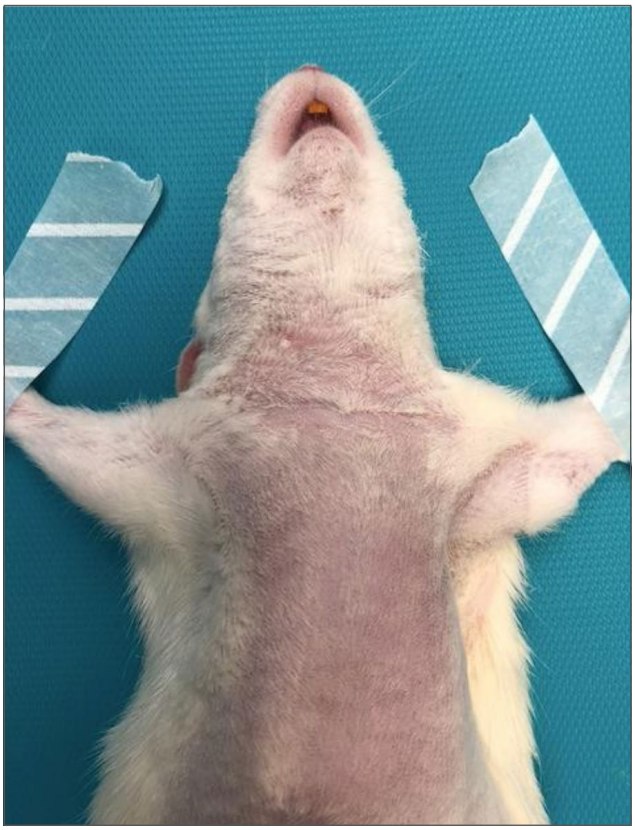

Figure 5. Rat n°5 at D30 post-operation.

- flying stitch: rat n°10;
- transfixing stitch: rat n°1, 4 and 7;
- intimal FLAP: rats n°3, 6 and 10;
- arteriotomy too wide: rat n°4.

DISCUSSION

A total of three rats (n°5, 8 and 9) had the double anastomosis permeable, but only n°5 was retained for monitoring.

For rat n°3, the flap was not viable due to over-intensive manipulation of the epigastric bundles; while for rat n°6, the flap was twisted.

Evaluation of the anastomoses of rats n°4 and 7 performed post-care found mainly transfixing points. This may be due to the fact that gestures are abrupt and less precise in a state of fatigue.

In the case of failed anastomoses, we noted the recurrence of FLAPs narrowing the caliber and causing flow disturbance and thrombus at the origin of the failure. Incorrect use of DUMONT n°5 forceps during the last stitch performed without intra-luminal control may explain this recurrent error.

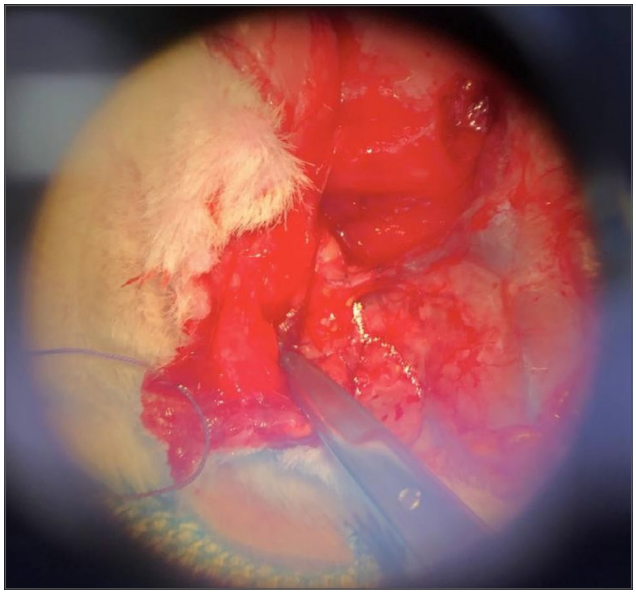

Figure 6. Venous anastomosis at D30 in rat no. 5.

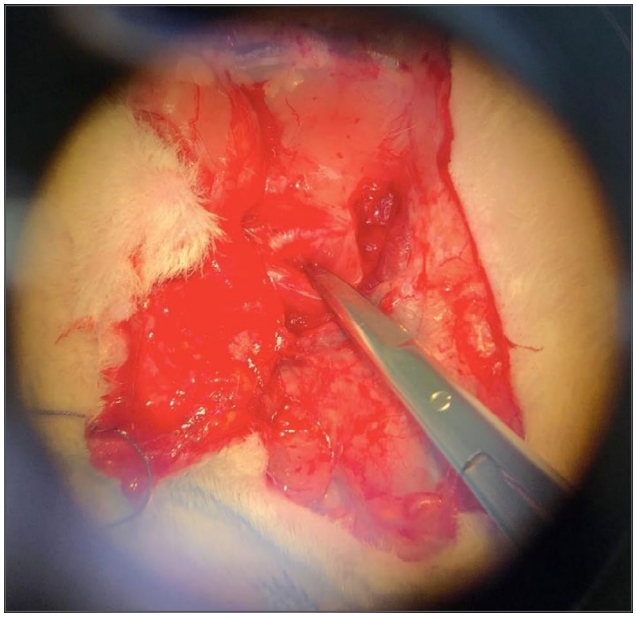

Figure 7. Arterial anastomosis at D30 in rat no. 5.

Secondly, arteriotomy and venotomy are also delicate procedures. There is a risk of over-opening vessels under tension, which can lead to failure.
As the sessions progressed, I decided to carry out my arteriotomies and venotomies by bringing the Gilbert double clamp bits a little closer together and making smaller openings, even if it meant enlarging them delicately afterwards using n°5 forceps.
Dissection time and microsurgical time progressively decreased (rat n°1 *versus* rat n°10).

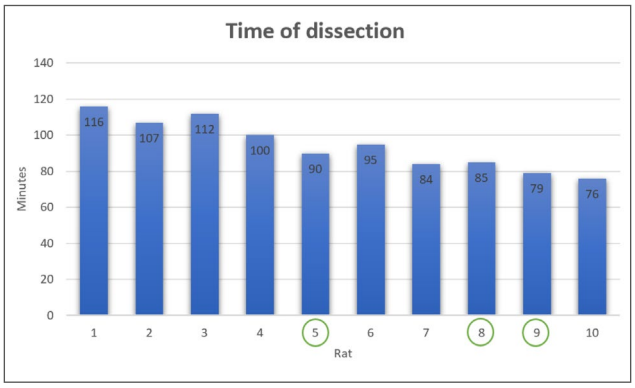

Figure 8. Dissection time in minutes. Green circle: successful double anastomosis.

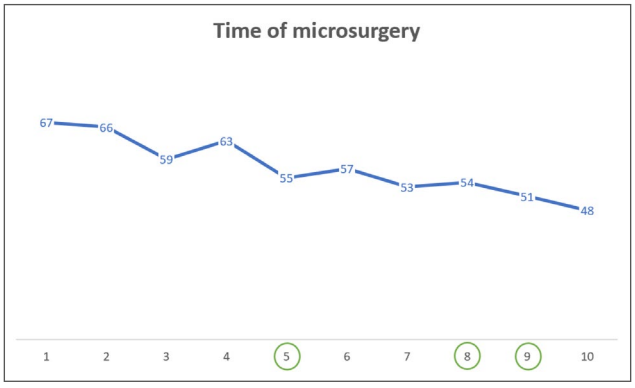

Figure 9. Microsurgery time in minutes.

Dissection time decreased only slightly over the last few sessions, but they were of better quality. Gestures were more precise and safer, and dissection quality was markedly improved by the use of hydrodissection.
Finally, there are a number of subtleties concerning the flap itself: it must be handled with care, avoiding tension on the epigastric vessels and taking care to position it correctly when performing the anastomoses in order to avoid twisting the pedicle, but also to encourage venous return by positioning it on the animal's chest and not in the down position.
Evaluation of the anastomoses at 30 days for rat n°5 revealed thrombosis of the artery and vein, despite clinical viability of the flap. This viability is probably linked to peripheral reintegration initially supported by the anastomoses.
These situations underline the multitude of factors influencing the final success of a flap, a source of frustration when the sutures themselves are successful. The operator needs to be concentrated at every stage of the procedure, and it's only through a strict process that errors

can be avoided. Learning from my sessions has enabled me to draw up a checklist for successful anastomosis:

Set-up and dissection

- Use a 30° hot plate to warm the rat and hydrate it.
- Make maximum use of hydrodissection to identify collaterals without severing them.
- Never tension epigastric vessels.
- Dissect and ligate femoral vessels as far as possible towards the crural arch, to ensure sufficient length for anastomosis.
- Degrease all vessels.
- Make a transverse arteriotomy and venotomy, clean, not too large, perpendicular to the blood flow and at a distance from the collaterals.

Concerning the anastomosis

- Identical bank widths.
- Do not overtighten knots.
- Take the intima and media with each pass, introducing the forceps into the lumen to avoid flap.
- Cut chiefs short enough to prevent them from becoming lodged in the lumen.

For the operator

- Master the instruments by applying your hands to a fixed plane.
- Keep calm and avoid sudden movements
- Keep your back straight throughout the session
- Carry out sessions under the right conditions
- Maintain self-confidence while remaining humble right up to the final gesture.

CONCLUSIONS

This scientific work has highlighted the demanding nature of microsurgical practice, which requires ongoing training in a constant quest for excellence. It's a long journey, in which regular practice and absolute rigor enable the gradual acquisition of skills.
Some sessions can be extremely uncomfortable, leading to constant self-questioning. Indeed, having to learn how to manage your time, remain patient, overcome stress and recurrent mistakes quickly gives way to frustration, annoyance and the idea that you'll never succeed.
By dint of perseverance, we learn to become demanding of ourselves, to accept failures so as to bounce back better and never make the same mistakes again.
There's no doubt that these many hours of practical work will be an undeniable asset in my future practice as a hand surgeon, both from a technical point of view and in terms of self-control.

Conflict of interest statement
The authors are no conflict of interest.

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Author contributions
SJ and SS contribuited equally to the work. PB: corrected the article.

Ethical consideration
The scientific use of these animals complies with French (decree 2013-118 and five orders dated February 1, 2013) and European (directive 2010/63) legislation. This experimentation has been validated by an ethics committee and is carried out with respect for the animal's integrity, taking into consideration its well-being and pain management.

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