

CEA: What is the current best patch if any? EAC: Quel est le meilleur patch (s'il existe) ?



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Disclosure

Speaker name: Alan Dardik

.....

- I have the following potential conflicts of interest to report:
 - Consulting
 - Employment in industry
 - Shareholder in a healthcare company
 - Owner of a healthcare company
 - Other(s)
- I do not have any potential conflict of interest

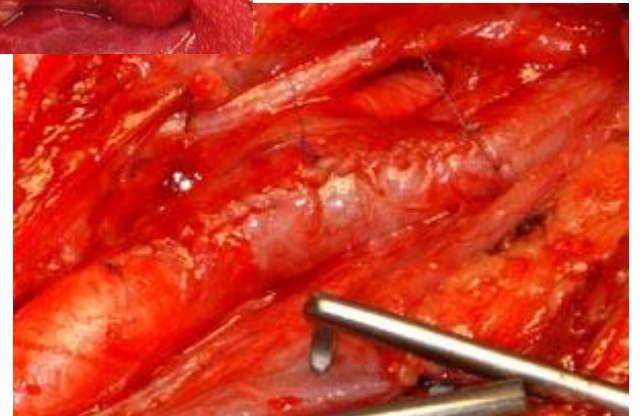
Patches

Les patches

- Simple technique
- No contraindications
- Good for small arteries, shunt use, ↑ bifurcations



- Time consuming
- Potential prosthetic implant



Patching after CEA is associated with...

Utiliser un patch après une EAC est associé à ...

- **reduced 30-day risk of ipsilateral stroke**
 - 1.6% vs. 4.8%, $p=.001$
- **reduced risk of stroke or death**
 - 2.5% vs. 6.1%, $p=.007$
- **reduced rates of return to surgery**
 - 1.1% vs. 3.1%, $p=.01$
- **reduced rates of arterial occlusion**
 - 0.5% vs. 3.6%, $p=.0001$



Bond et al. Cochrane Database Syst Rev 2004; (2):CD000160.

Bond et al. J Vasc Surg. 2004 Dec;40(6):1126-35.

The ideal patch

Le patch idéal

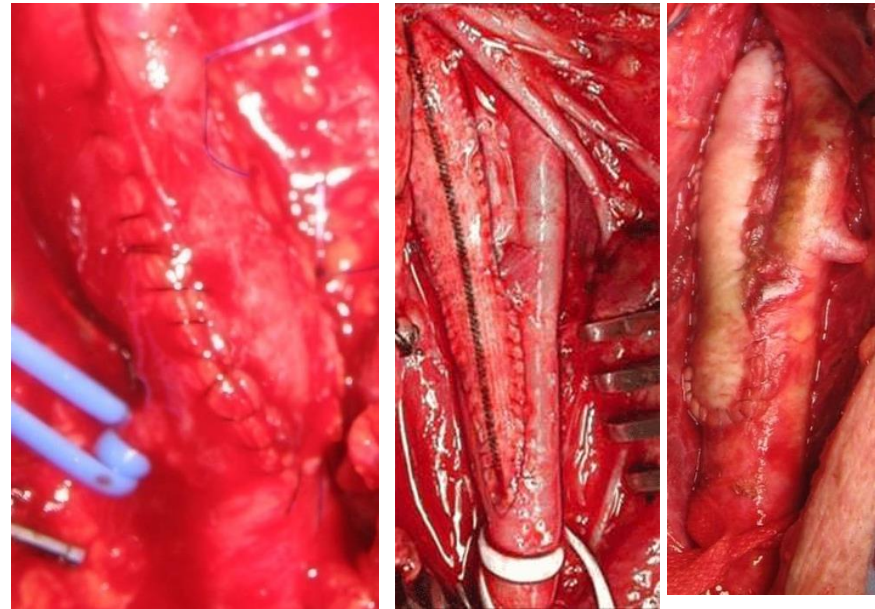
- long term stability and durability
- low risk of restenosis
- compliance near that of the host artery
- comfortable handling characteristics
- easy harvest or ready to use
- anti-coagulant function
- resistance to infection and late degeneration



Patch options

Patches: les options

- **Autologous**
 - Vein
- **Prosthetic**
 - Dacron
 - PTFE
 - Pericardial
- **Future ??**
 - Tissue engineered



Patch options - Autologous vein

Patches: les options - veine autologue

Greater Saphenous vein

Lesser saphenous vein

Established

grafts

Biocompatible

excellent long-term outcomes

Excellent hemostasis

Easy suturing

Autologous

Readily available

Easy to use



Patch options - Autologous vein

Patches: les options - veine autologue

Everted cervical vein

Facial or ext. jugular vein

Established

Biocompatible

excellent long-term outcomes

Excellent hemostasis

Easy suturing

double thickness sometimes hard



Clinical experience with everted cervical vein as patch material after carotid endarterectomy

J Vasc Surg 1997;25:545-53.

Herbert Dardik, MD, Fred Wolodiger, MD, Fred Silvestri, MD, Barry Sussman, MD, Mark Kahn, MD, Kurt Wengerter, MD, and Ibrahim M. Ibrahim, MD, *Englewood, N.J.*

Patch options - Autologous vein

Patches: les options - veine autologue

Cryopreserved homograft saphenous vein patch

saphenous vein harvested during CAB (>3mm, from thigh)
cryopreserved in 10% DMSO at -120°C (up to 3 years)

Excellent results reported by Plestis (1996)

1006 cases

1.2% strokes, 96% 10-year freedom from stroke

2% restenosis (>75%), 84% 10-year freedom from restenosis

Plestis KA, Kantis G, Haygood K, Earl N, Howell JF. Carotid endarterectomy with homologous vein patch angioplasty: a review of 1006 cases. *J Vasc Surg.* 1996 Jul;24(1):109-19.

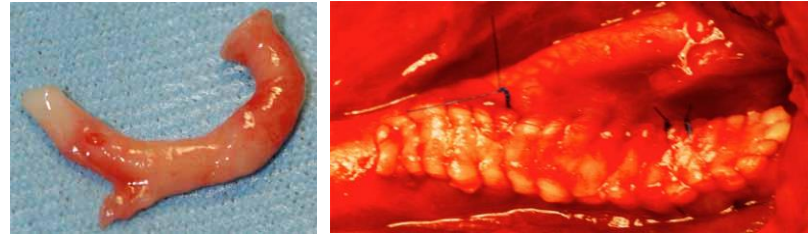
Carotid endarterectomy with homologous
vein patch angioplasty: A review of 1006 cases

Konstadinos A. Plestis, MD, George Kantis, MS, Kenneth Haygood, MD,
Nan Earl, BS, and Jimmy F. Howell, MD, *Houston, Tex.*

J Vasc Surg 1996;24:109-19

Patch options - Autologous artery

Patches: les options - artère autologue



Superior Thyroid Artery

Jenkins MP, Aly S, Sarin S, Adiseshiah M. Patch angioplasty following carotid endarterectomy using the ipsilateral superior thyroid artery. Eur J Vasc Endovasc Surg. 1997;14(1):60-2.

advantages: excellent strength, reduced cost, excellent compliance match to host artery, available in field
disadvantages: reduced patch size, focal arteriosclerosis, potential for distal ischemia

Common Carotid Artery

Endarterectomized Occluded Superficial Femoral Artery

Bastounis EA, Maltezos CK, Balas PE. Carotid endarterectomy and patch angioplasty, utilizing a segment of autogenous endarterectomized superficial femoral artery. A case report. Int Angiol. 1995 Jun;14(2):209-13.

advantages: eliminate potential for distal ischemia
disadvantages: ??

Patch options - Prosthetic

Patches: les options - prothèse

Polyester (Dacron)

Established, similar to other products
grafts, umbilical tapes

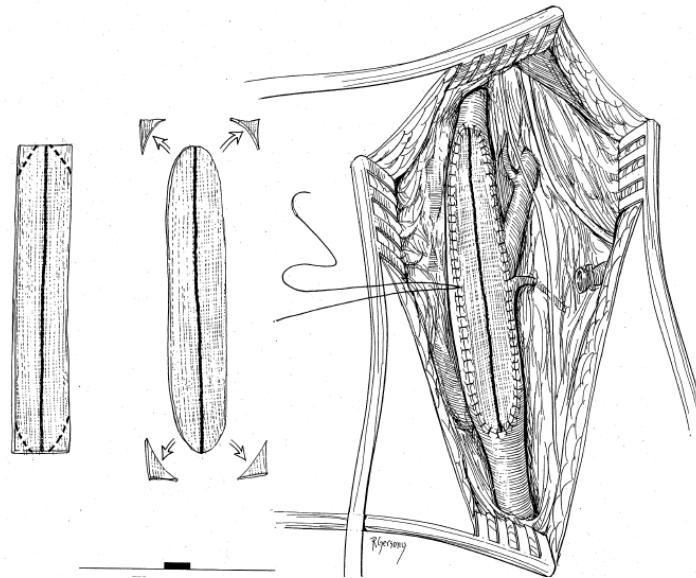
Many sizes available

Biocompatible

good tissue ingrowth

Excellent hemostasis

“Easy” suturing



Patch options - Prosthetic

Patches: les options - prothèse

PolyTetraFluoroEthylene (PTFE)

carbon-fluoride resin, porous structure

20-30 μm fibril distance

Established, similar to other products
grafts

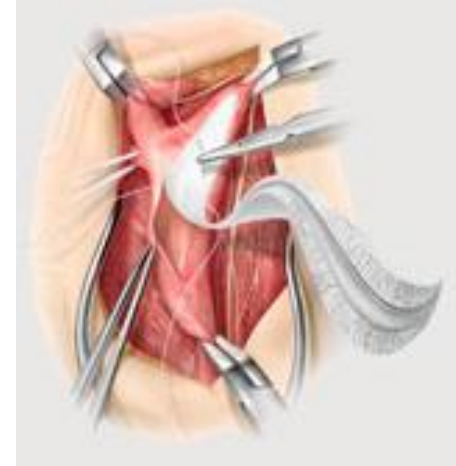
Many sizes available

Biocompatible

good tissue ingrowth

“Excellent” hemostasis

“Easy” suturing



Catalogue Number	Nominal Thickness (mm)	Nominal Width (cm)	Nominal Length (cm)
1CVX002	0.5	1	9
1CVX003	0.5	0.8	7.5
1CVX004	0.5	2.5	15

Patch options - Prosthetic

Patches: les options - prothèse

Bovine or Porcine pericardium

Established, similar to other products
anastomosis reinforcement

Many sizes available

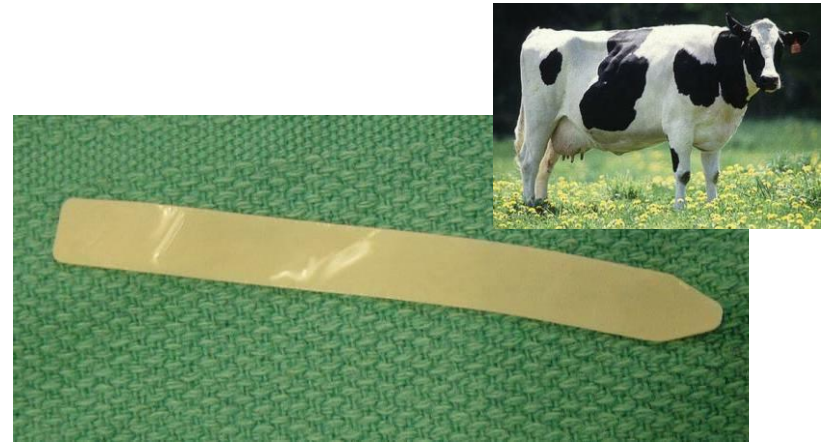
Biocompatible

good tissue ingrowth
use in an infected field

Excellent hemostasis

Easy suturing

Early duplex



Outcomes of patches

Résultats des patchs

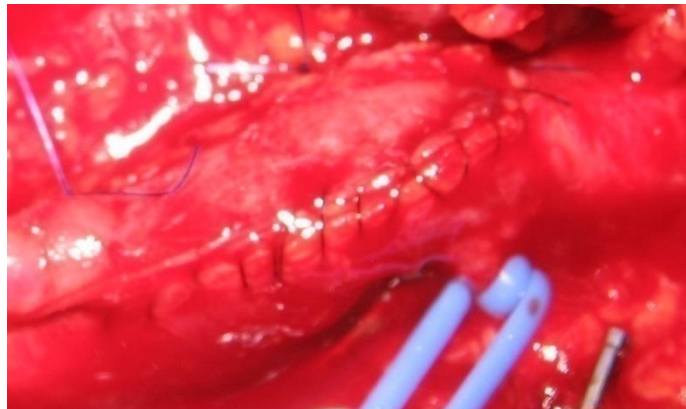
- Best established for CEA
- Extensive data for individual patch materials
- Some data comparing patch materials



Autologous vein patches

Patchs veineux autologues

- First patch material
 - only autologous available
- Many series with excellent results
- Essentially NO reports of patch infection or pseudoaneurysm



Autologous vein patches

Patchs veineux autologues

- Jacobowitz – NYU 2001
 - 159 vein patches vs. 90 Dacron patches
 - Stroke: vein **1.3%**, Dacron **1.1%** (p=ns)
 - Restenosis: vein **2.2%**, Dacron **8.5%** (p=ns)
 - Jacobowitz GR, Kalish JA, Lee AM, Adelman MA, Riles TS, Landis R. Long-term follow-up of saphenous vein, internal jugular vein, and knitted Dacron patches for carotid artery endarterectomy. *Ann Vasc Surg.* 2001;15(3):281-7.
- O'Hara – Cleveland Clinic 2002
 - 207 cases, randomized vein/synthetic patch
 - Stroke: vein **3.0%**, synthetic **2.1%** (p=.99)
 - Restenosis: vein **4.8%**, synthetic **6.3%** (p=.99)
 - O'Hara PJ, Hertzner NR, Mascha EJ, Krajewski LP, Clair DG, Ouriel K. A prospective, randomized study of saphenous vein patching versus synthetic patching during carotid endarterectomy. *J Vasc Surg.* 2002 ;35(2):324-32.

Dacron and PTFE patches

Patchs en Dacron et PTFE



- Dacron first material to be “off the shelf”
- PTFE became very popular upon introduction
 - But less so with suture hole bleeding
- Recent prosthetics with little disadvantage compared to vein
 - Similar rates of restenosis and occlusion
 - OR 1.01, 95% CI = 0.61-1.66

Comparison of different patch materials

Comparaison entre les différents matériaux de patch

Study	n			stroke			restenosis		
	vein	Dacron	ePTFE	vein	Dacron	ePTFE	vein	Dacron	ePTFE
AbuRahma 1996	130	-	134	0.8%	-	2.2%	2.9%	-	2.2%
Archie 2000	903	359	27				0.6%	6.4%	3.7%
Jacobowitz 2001	159	90	-	2.0%	2.2%	-	2.2%	8.5%	-
Grego 2003	80	-	80	1.3%	-	6.4%	9.3%	-	13.3%
Naylor 2004	134	133	-	4.5%	7%	-	1.6%	7.1%	-
AbuRahma 2008	-	100	100	-	3%	2%	-	21%	11%

?? Increased restenosis in Dacron patches ??

Prosthetic patches

Patchs prothétiques

- Infection, pseudoaneurysm
 - Unusual (0.37%) but treatable
 - Some suggest life-long surveillance needed in susceptible populations
 - Suggests that Dacron and PTFE are not perfect

Postoperative Complications of Carotid Patching: Pseudoaneurysm and Infection

Boris H. Borazjani, MD, MPH,¹ Samuel E. Wilson, MD,² Roy M. Fujitani, MD,² Ian Gordon, MD, PhD,² Mark Mueller, MD,³ and Russell A. Williams, MD,² San Diego, Irvine, and Los Angeles, California

Ann Vasc Surg 2003; 17: 156-161

Dacron Patch Infection after Carotid Endarterectomy: Case Report and Review of the Literature

Shyam Krishnan, MD, and Alexander W. Clowes, MD, Seattle, Washington

Ann Vasc Surg 2006; 20: 672-677

Bovine pericardial patches





Patchs de péricarde bovin

- Excellent results from many series
- Off the shelf, durable, biocompatible
- Duplex immediately in operating room
- Use in infected fields reported
- No reports of BSE after carotid patches



Patch options

Patches: les options

- **Autologous**
 - Vein History of patch blowout
- **Prosthetic**
 - Dacron
 - PTFE
 - Pericardial Associated with infection, bleeding, pseudoaneurysms
- **Future ??**
 - Tissue engineered ↑ interest!
- **Future ??**
 - Tissue engineered Not yet available

How do patches heal?

Comment les patchs s'intègrent-ils?

- Does the body's cells infiltrate into the patch?
- Does the body cover the patch with cells?
- ***Does the body accept or reject the patch?***



Data? None!

Données? Aucunes!

- **No literature describing patch healing**
- **Unfortunate, since surveillance ultrasounds are often performed after patch surgery**
- **The carotid artery is not part of the standard sampling for an autopsy**



Method of patch study

Méthode d'étude des patches



bovine

porcine

implant pericardial patch into a Wistar rat

aorta

subcutaneous

study explanted patch

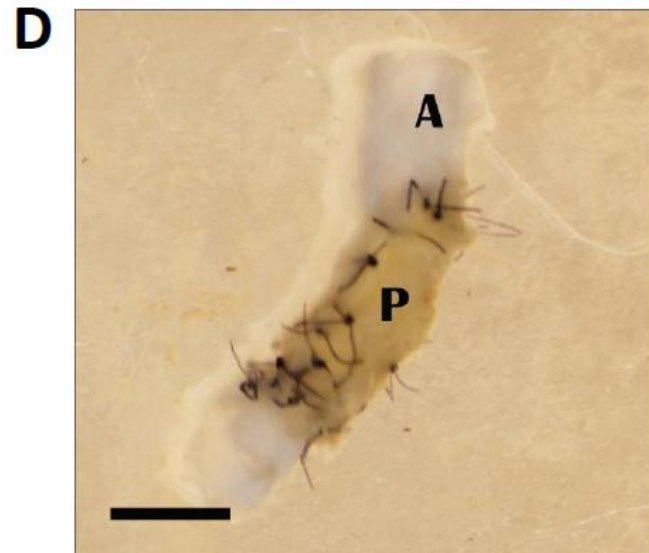
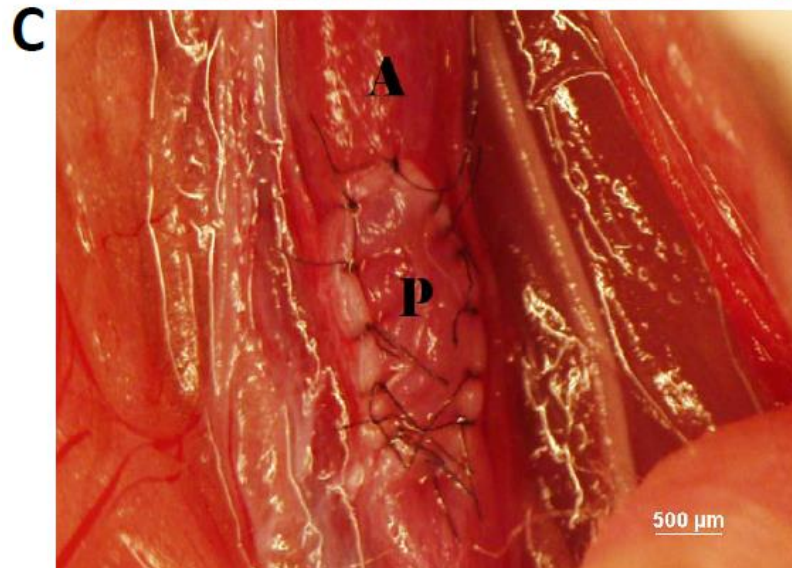
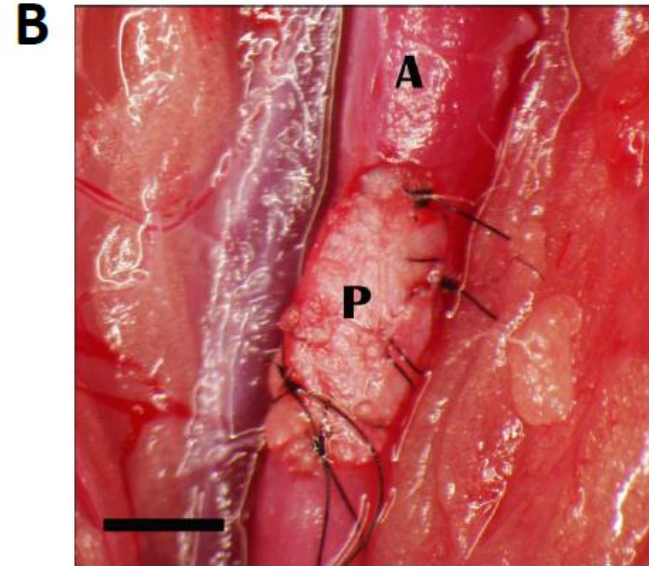
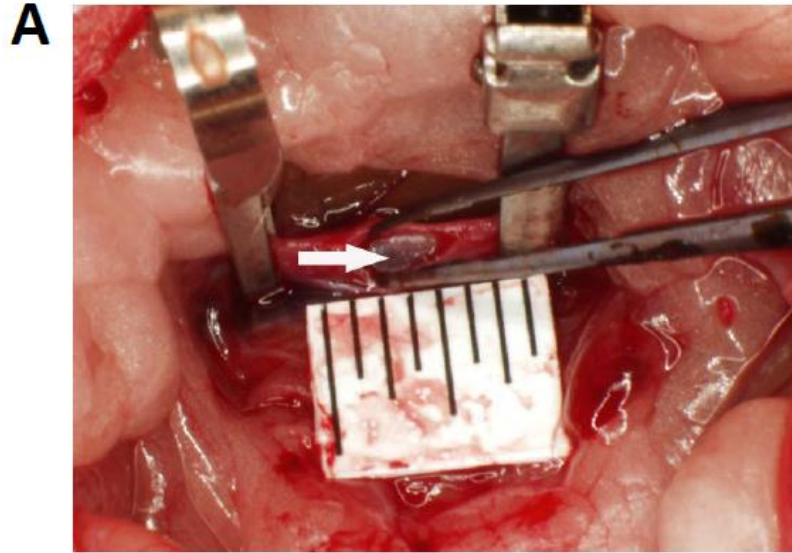
1-7 days

30 days



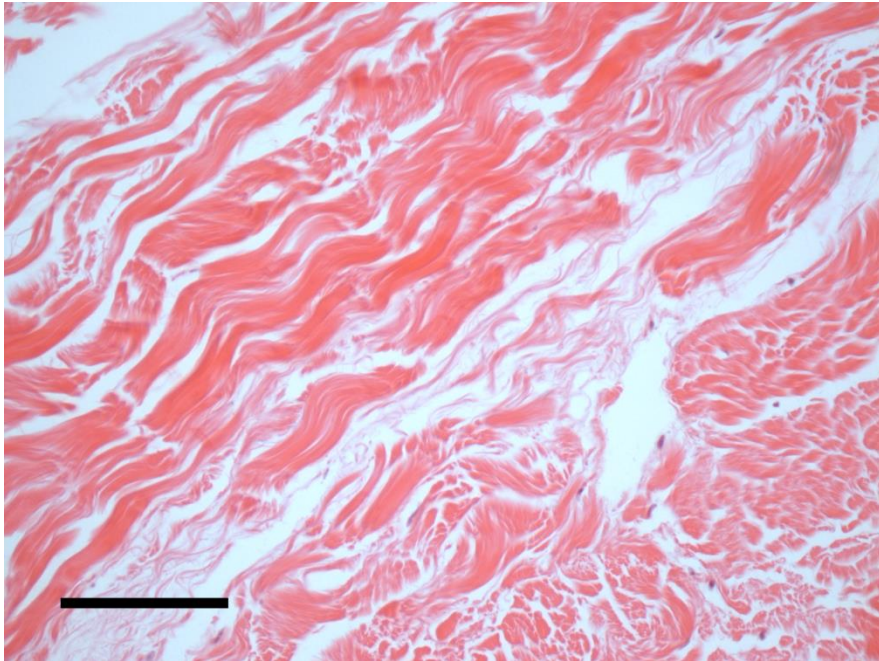
The implanted pericardial patch

Le patch péricardique implanté

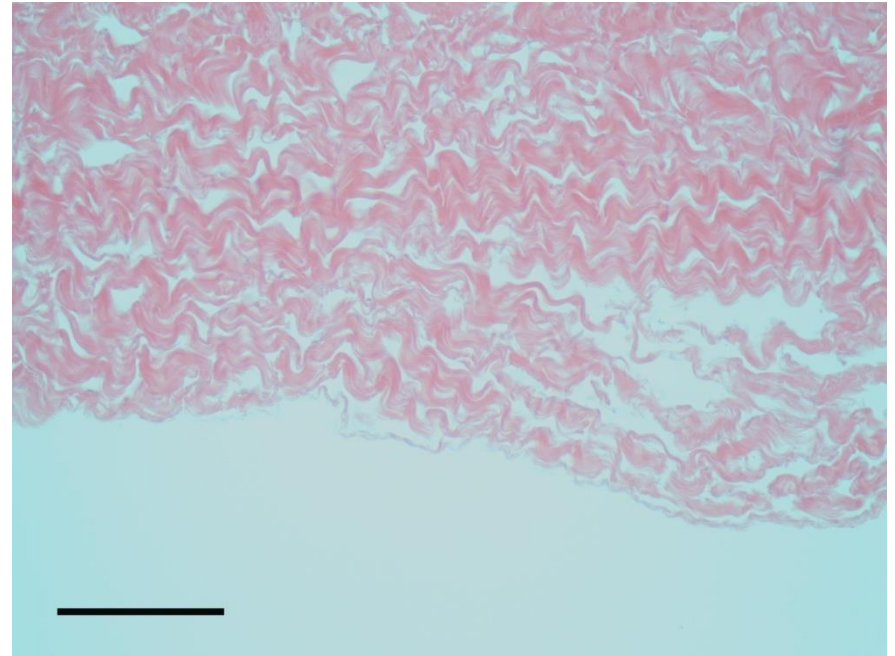


Preimplantation Patch

Patch pré-implantatoire



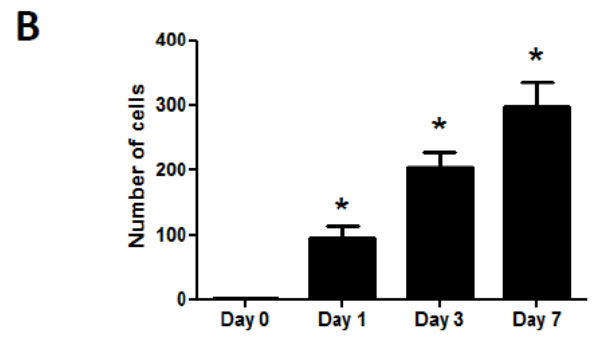
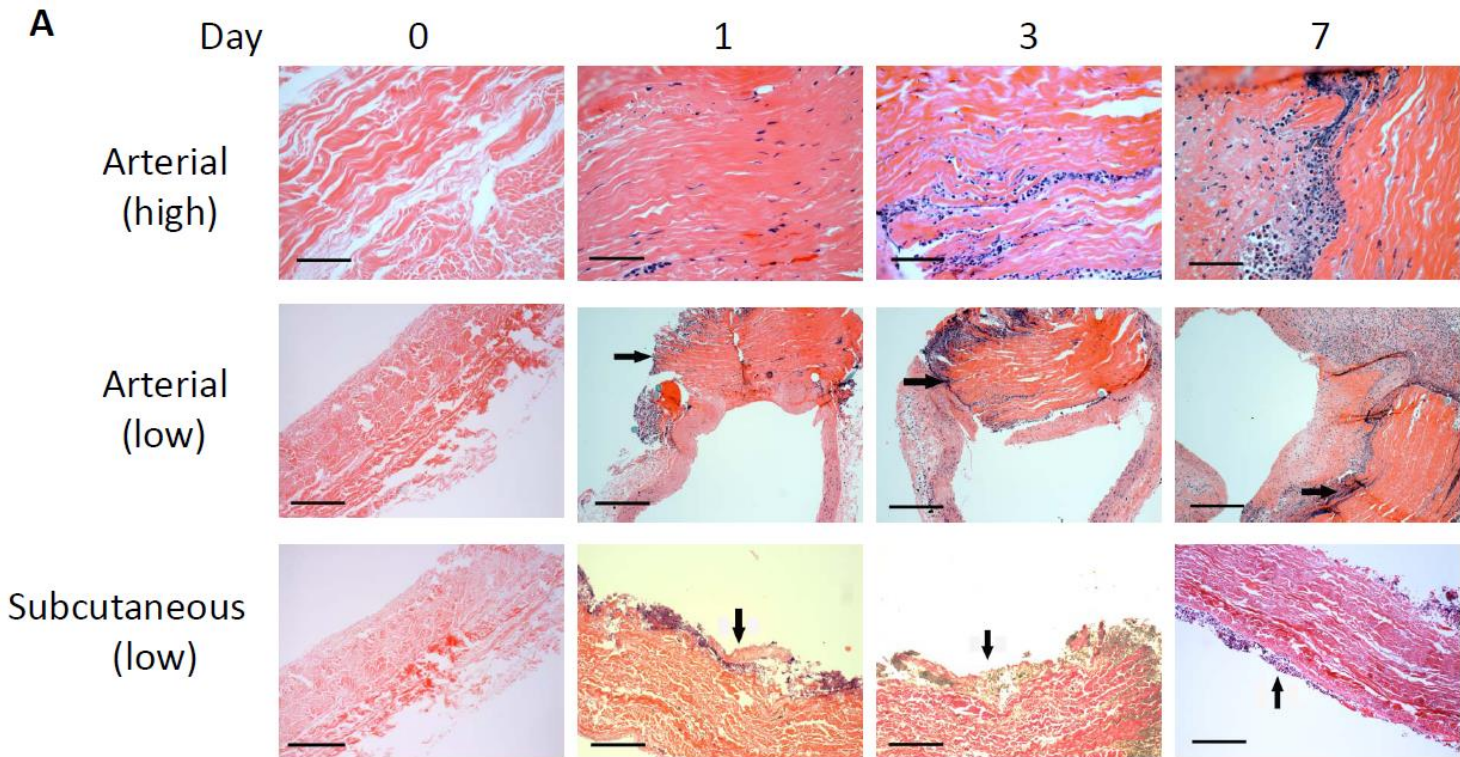
Bovine Patch



Porcine Patch

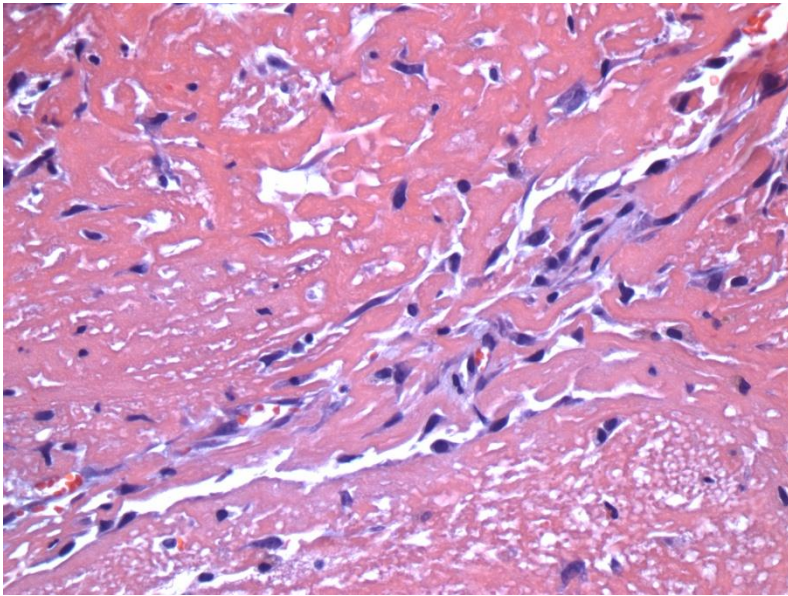
Cells infiltrate into the patch

Les cellules s'infiltrent dans le patch

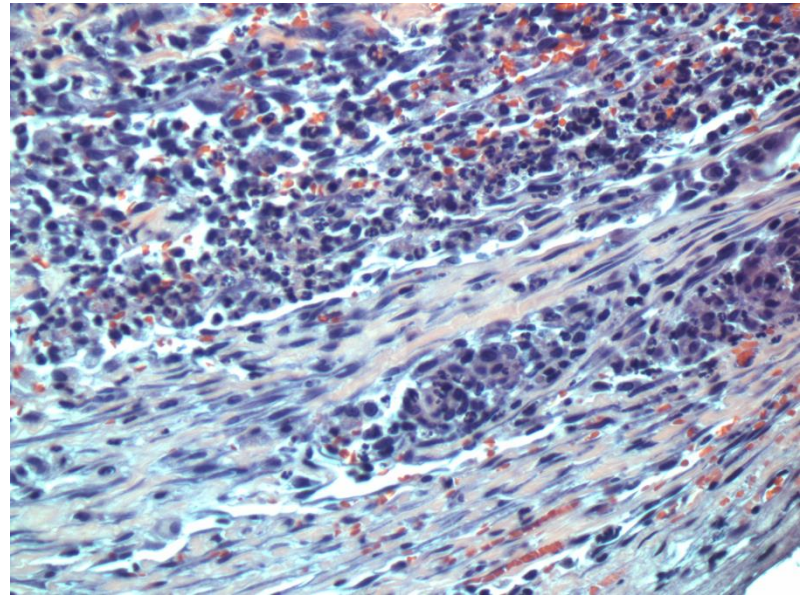


Histology of Pericardial Patches

Histologie des patchs péricardiques



Middle

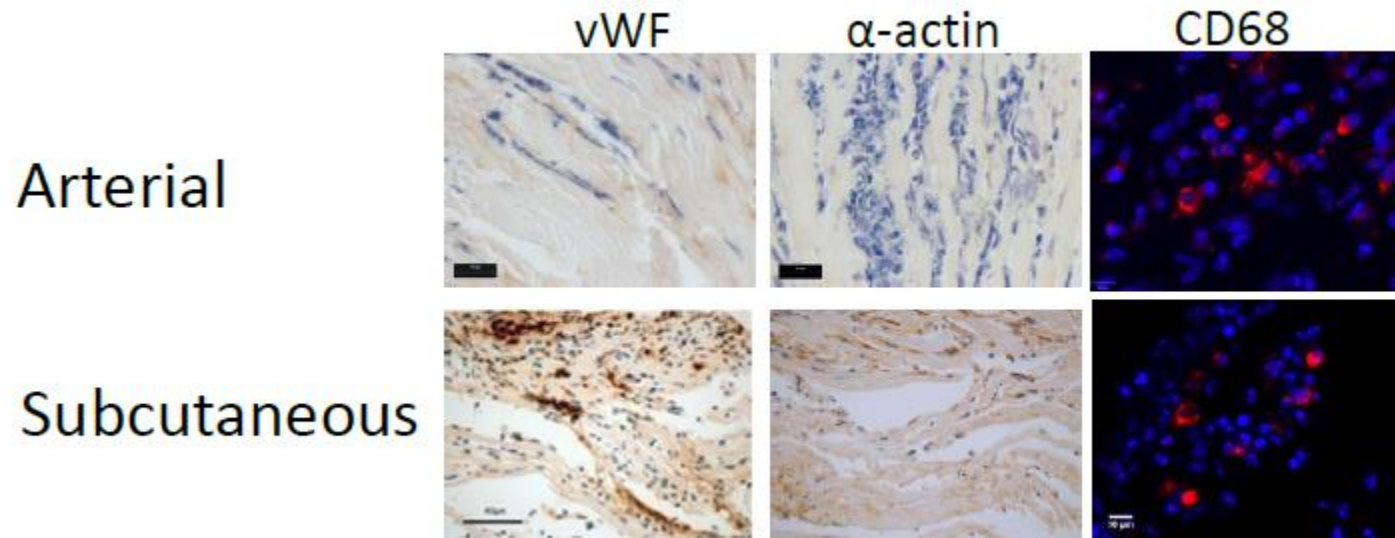


Outside Edge

Day 7 Patch: H&E staining, 40x

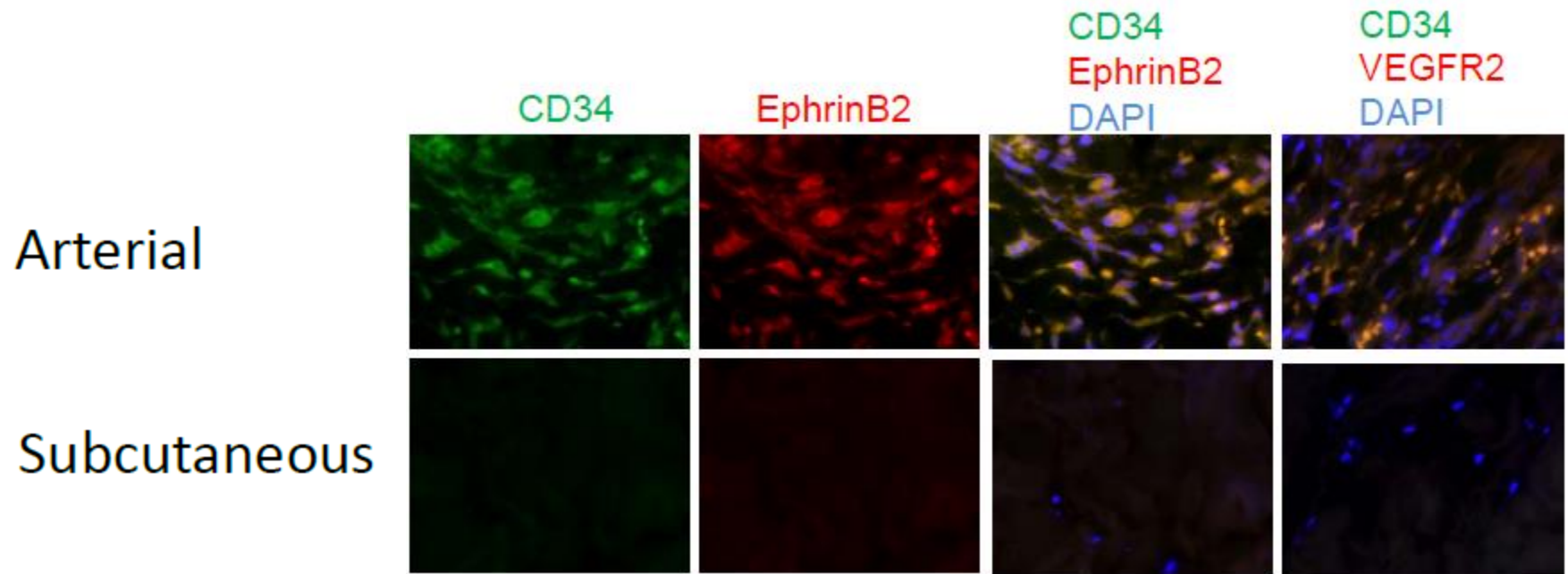
No vascular cells in the arterial patches! Pas de cellules vasculaires dans les patchs artériels!

(only a few macrophages)
(seuls quelques macrophages)



Arterial patches have arterial stem cells

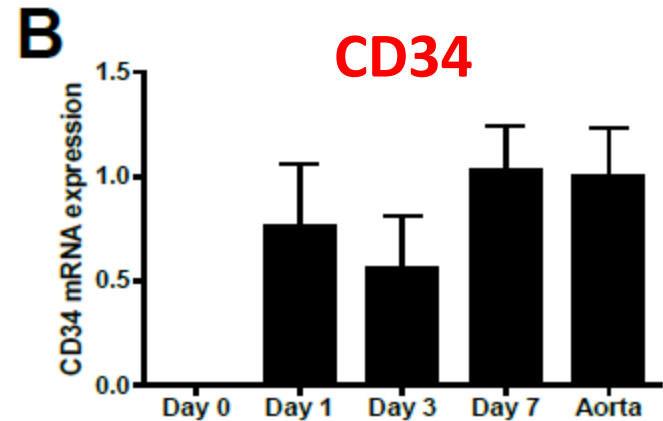
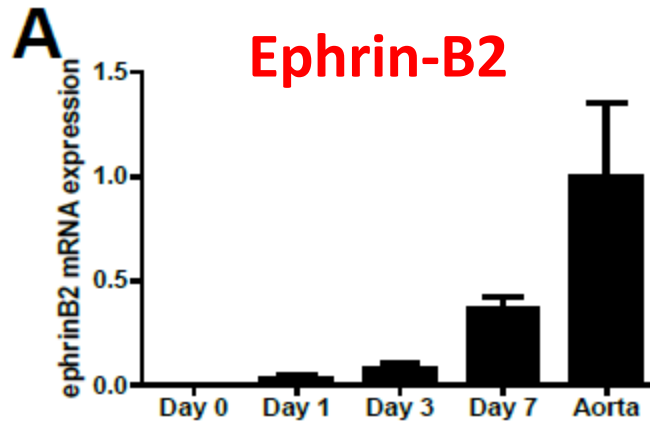
Les patchs artériels présentent des cellules souches artérielles



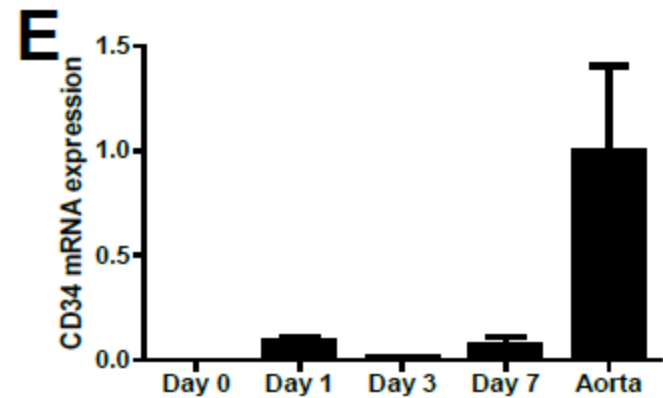
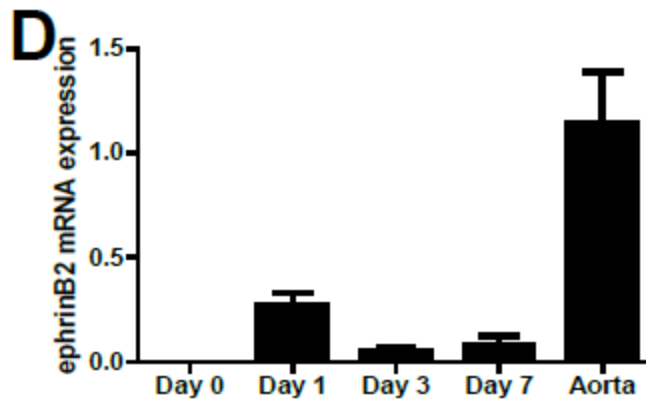
Arterial patches have arterial stem cell mRNA

Les patchs artériels présentent de l'ARNm de cellules souches

Arterial



Subcutaneous



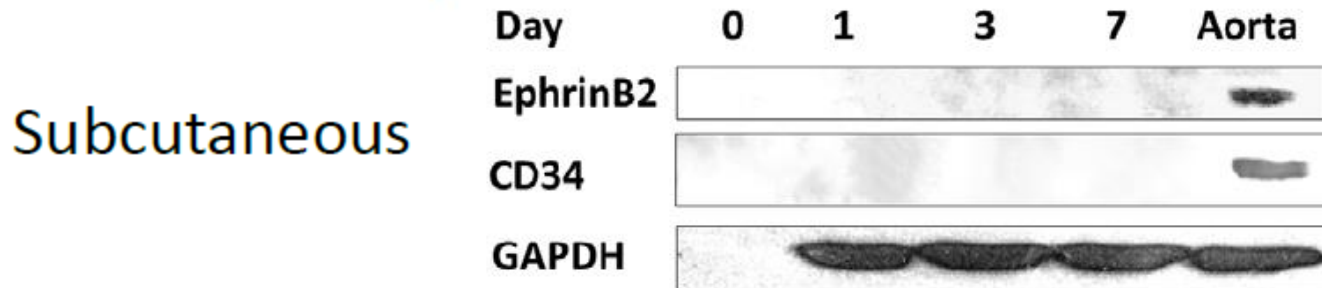
Arterial patches have arterial stem cell protein

Les patchs artériels présentent des protéines de cellules souches

C



F



Pericardial patches are covered with arterial stem cells

Les patchs péricardiques sont recouverts de cellules souches artérielles

CD34

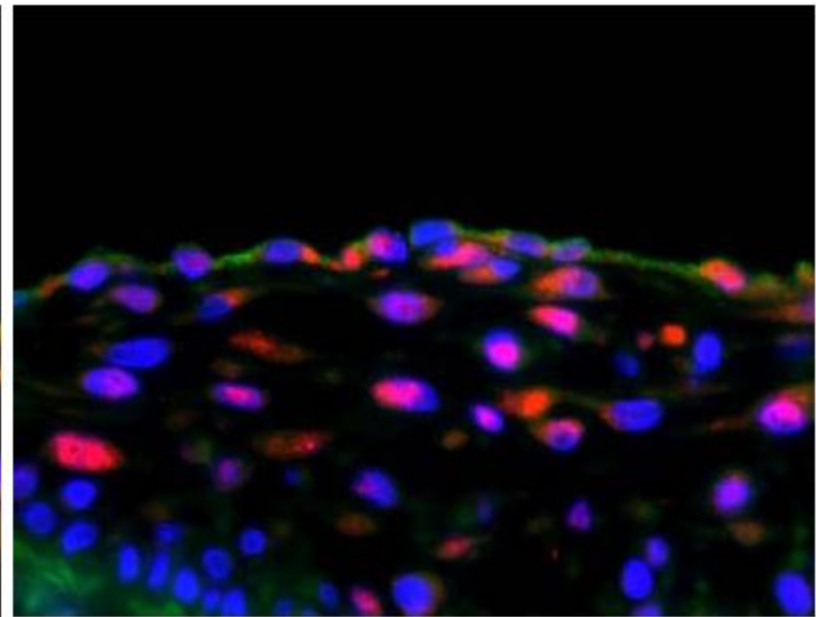
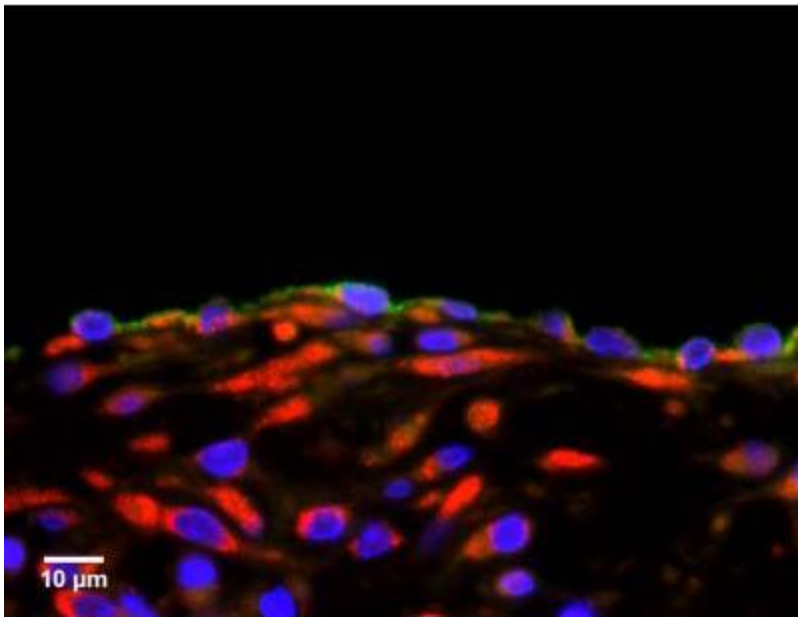
EphrinB2

DAPI

CD34

VEGFR2

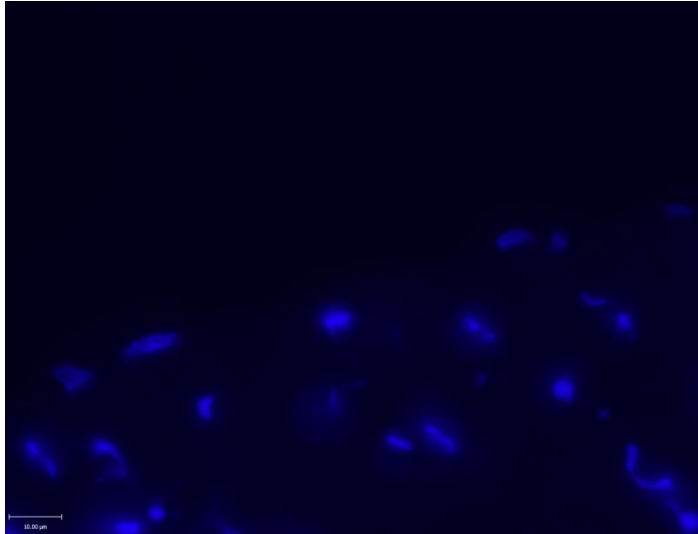
DAPI



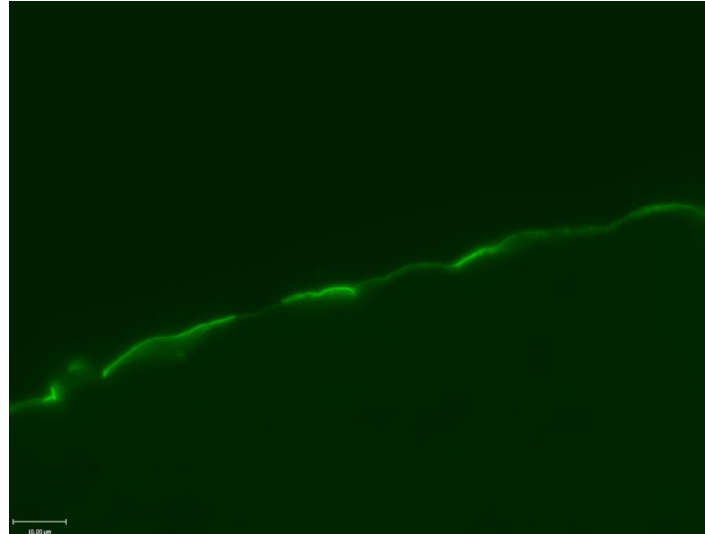
Pericardial Patches endothelialize

Les patchs péricardiques s'endothélialisent

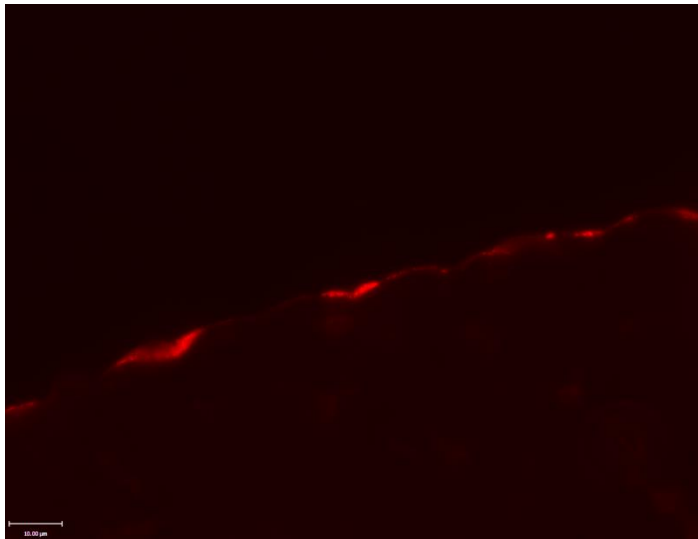
DPAI



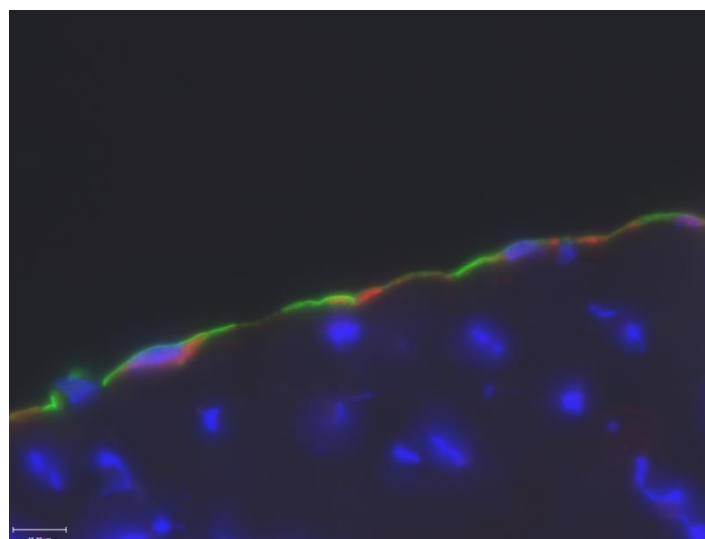
CD34



VEGFR2

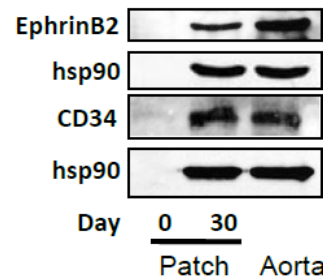
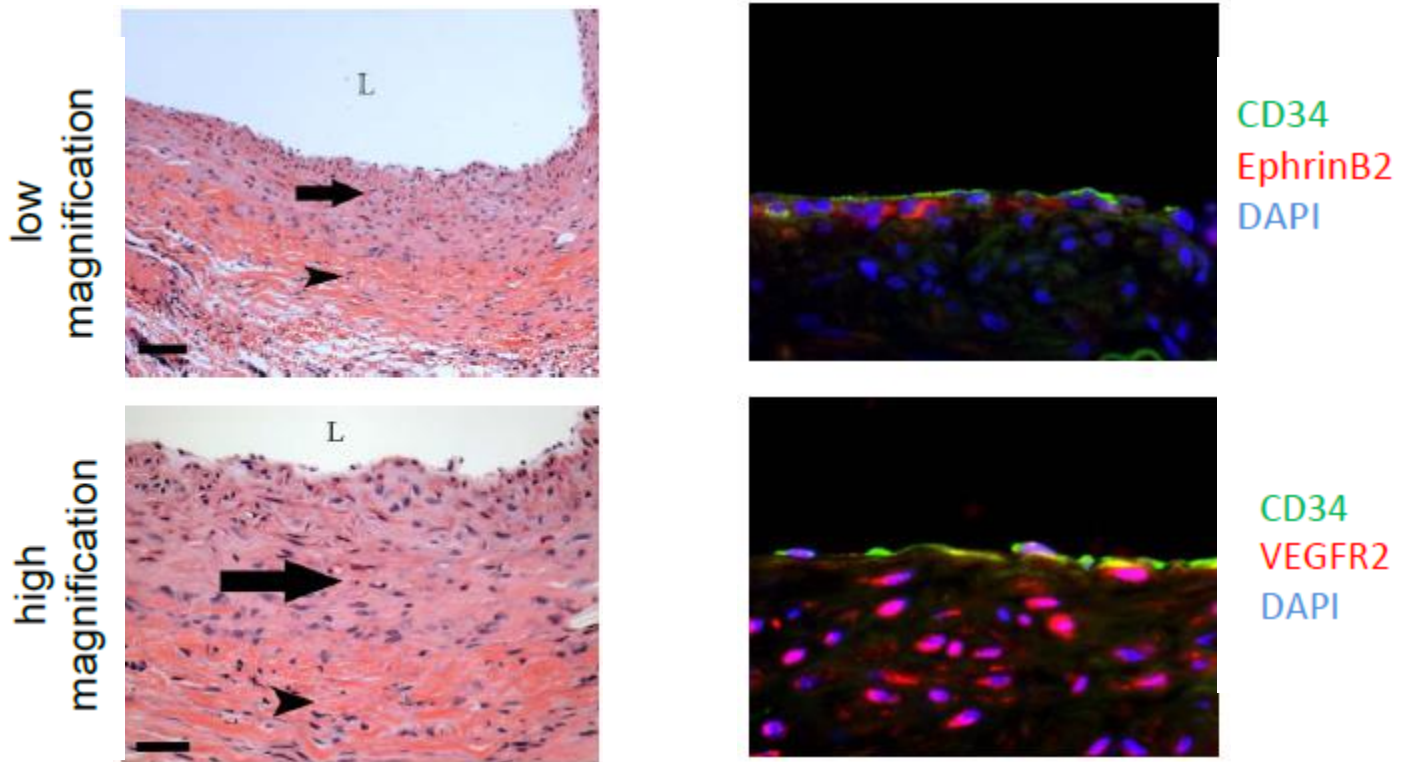


Merge



Pericardial patches are healed by 30 days

Les patchs péricardiques sont intégrés au bout de 30 jours



Pericardial Patches

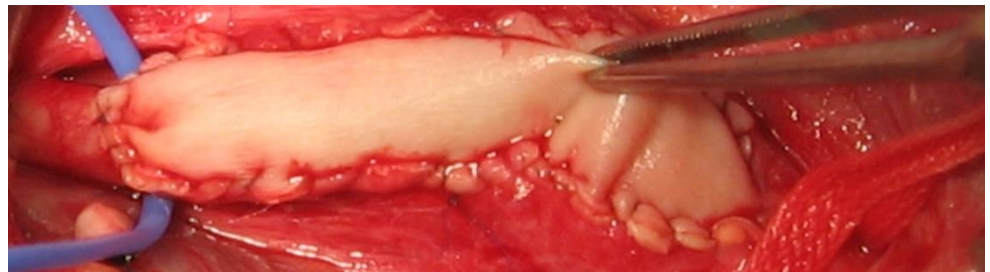
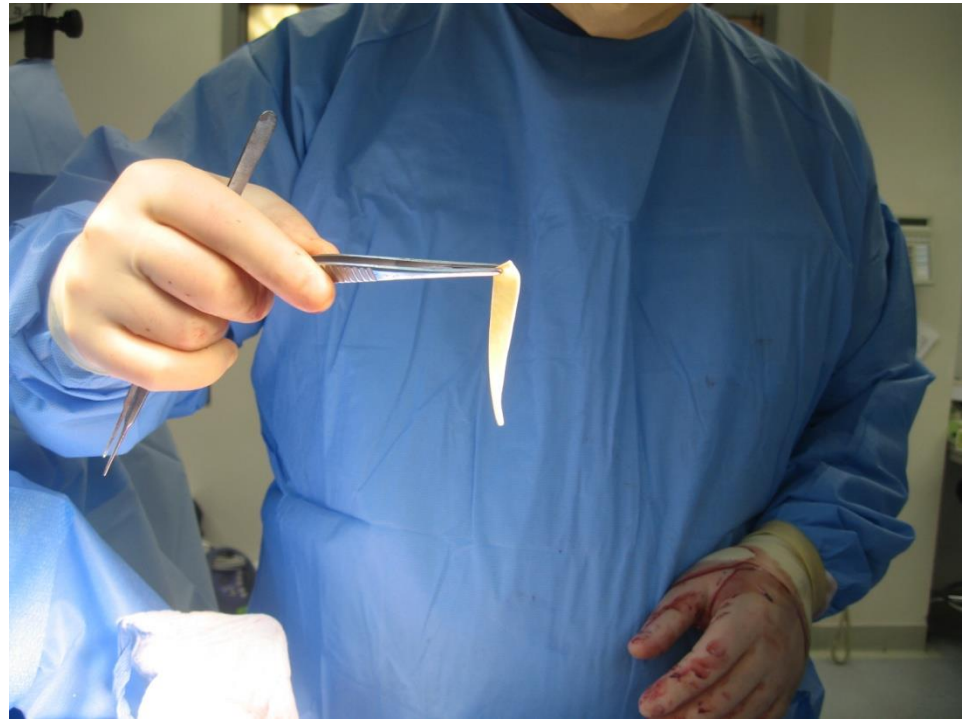
Patchs péricardiques

- **Cells infiltrate into the patch**
 - Macrophages
 - Arterial stem cells
- **Endothelialization of the patch by 1 week**
 - Arterial stem cells in endothelial position
 - Promotes normal healing, ? resistance to infection?
- **Complete neointima by 30 days**
 - Continued arterial stem cell presence

Why do I use pericardium?

Pourquoi dois-je utiliser un patch péricardique?

- **Established**
 - Nice CEA size available
 - Off the shelf
 - No reports of viruses
- **Biocompatible**
 - good tissue ingrowth
 - use in an infected field
- **Excellent handling**
 - Excellent hemostasis
 - Easy suturing & trimming
 - Good for surgical residents
- **Early duplex**
- **“Turns into an artery”**



Thank you

Merci

Yale University

