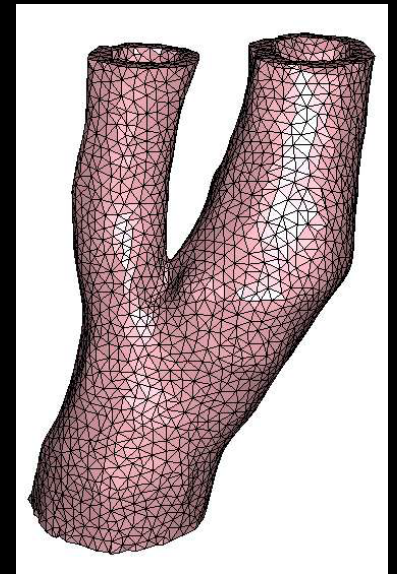
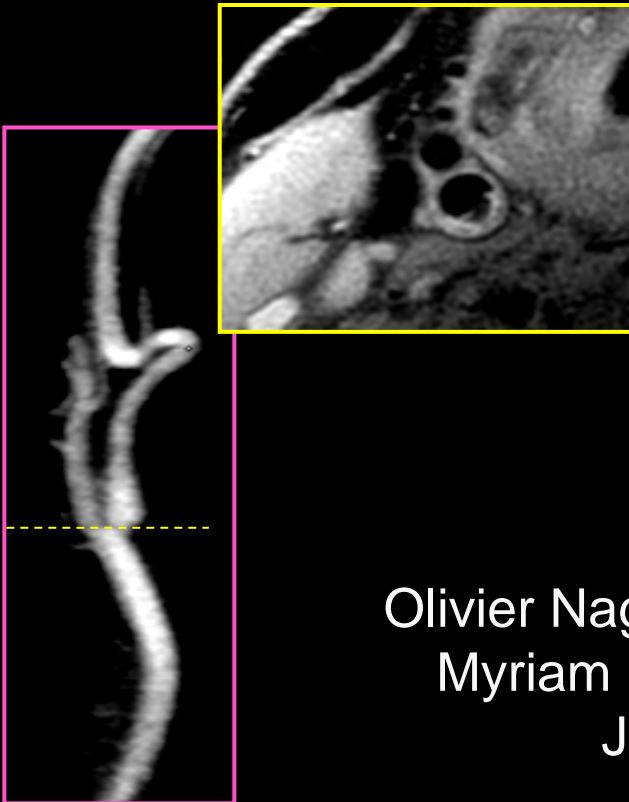


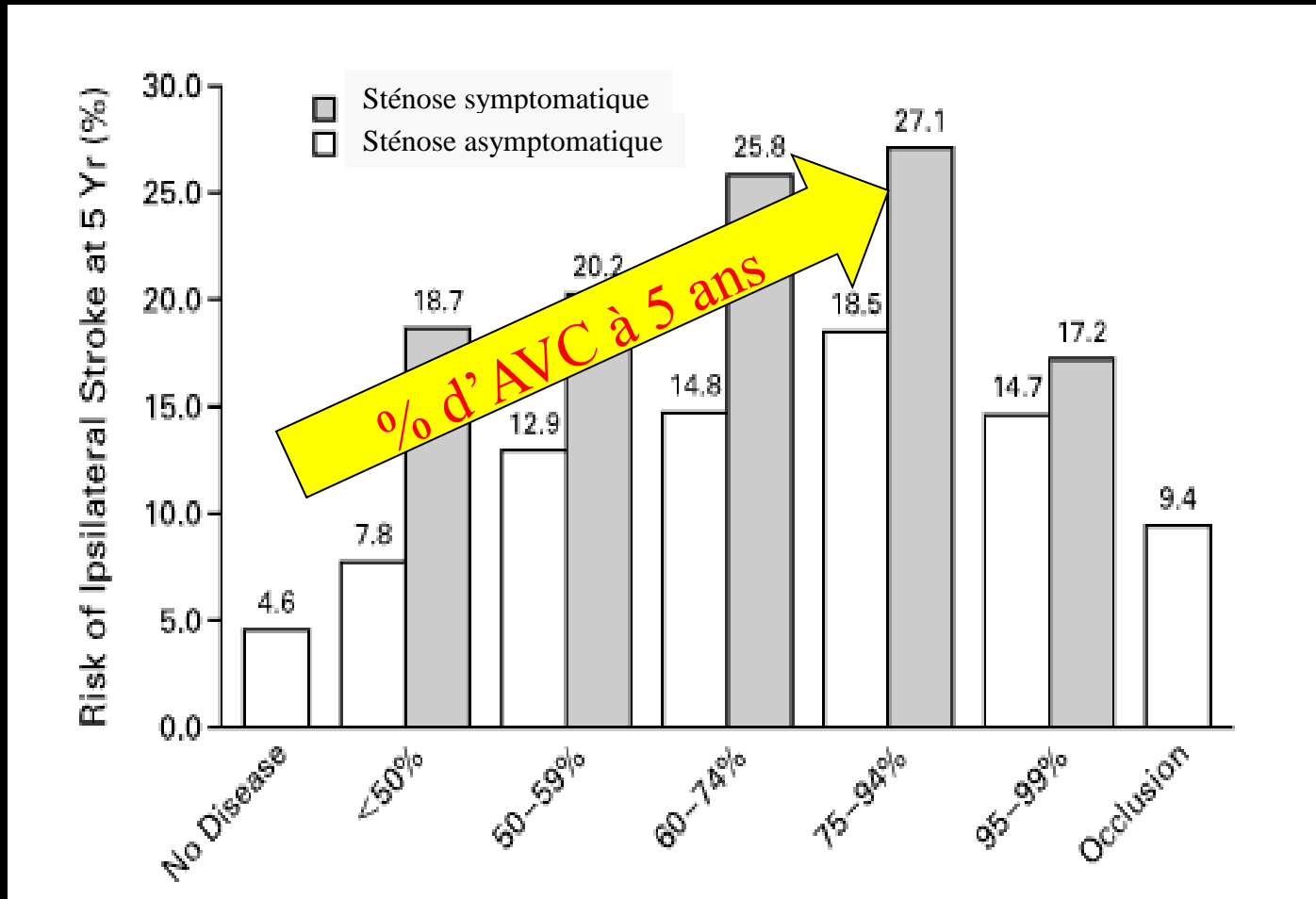
# Imagerie de la plaque athéromateuse de la bifurcation carotidienne Y a t'il une plaque dangereuse?



Olivier Naggara, Catherine Oppenheim,  
Myriam Edjlali, Wagih Ben Hassen,  
Jean Francois Meder

# Y a t'il une plaque dangereuse?

**Le risque d'AVC à 5 ans, sous traitement médical seul, augmente avec le degré de sténose**



# Y a t'il une plaque dangereuse?

Sténose carotide **symptomatique  $\geq 70\%$**

Chirurgie vs. Traitement médical (ECST + NASCET)

**Nombre de patients à traiter pour  
prévenir 1 événement à 5 ans**

<b>Hommes</b>	<b>Femmes</b>
9	36
<b>&gt;75 ans</b>	<b>&lt;65 ans</b>
5	15
<b>Chir&lt;2 sem</b>	<b>Chir&gt;12 sem</b>
12	125

# Y a t'il une plaque dangereuse?

- Angiographie
- Angio-scanner
- Ultrasons
- Angio-IRM



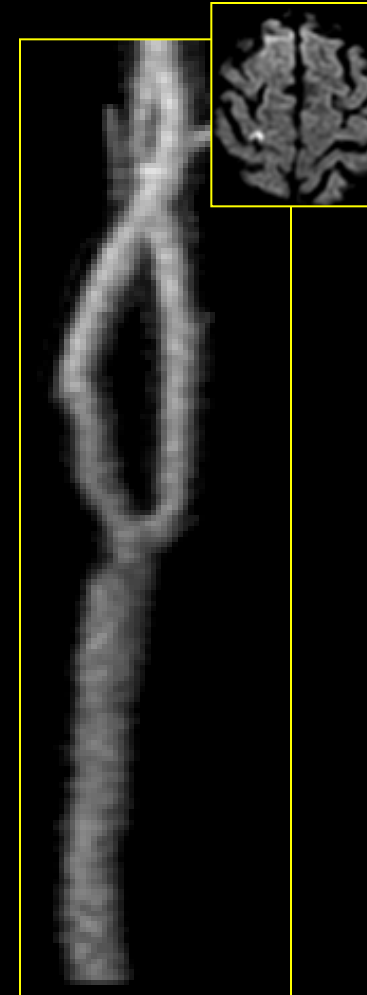
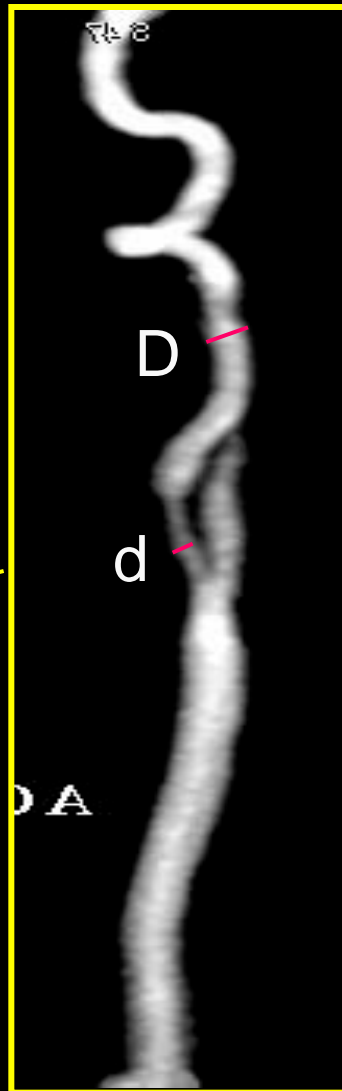
DUS	
<b>70-99% stenosis</b>	
Sensitivity (95% CI)	0.89 (0.85-0.92)
Specificity (95% CI)	0.84 (0.77-0.89)

CTA	
<b>70-99% stenosis</b>	
Sensitivity (95% CI)	0.77 (0.68-0.84)
Specificity (95% CI)	0.95 (0.91-0.97)

CEMRA	
<b>70-99% stenosis</b>	
Sensitivity (95% CI)	0.94 (0.88-0.97)
Specificity (95% CI)	0.93 (0.89-0.96)

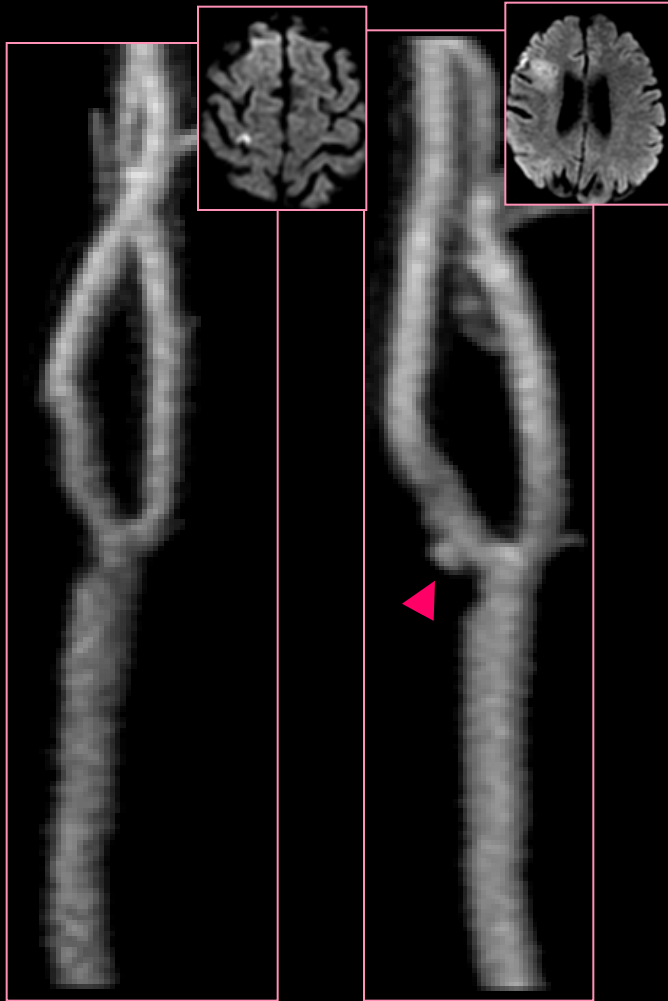
# Y a t'il une plaque dangereuse?

- Angiographie
- Angio-scanner
- Ultrasons
- Angio-IRM



<30%  
NASCET

# Plaque instable vs plaque stable morphologie de la sténose



<30%  
NASCET

1 an + tard

**Smooth stenosis**

**Ulcer type 1:** Ulcer comes out perpendicular to the lumen with parallel sides or sides that come to a point

**Ulcer type 2:** Ulcer has a narrow neck ("mushroom shaped") or no neck visible.

**Ulcer type 3:** Ulcer neck is proximal and main part of ulcer points distally.

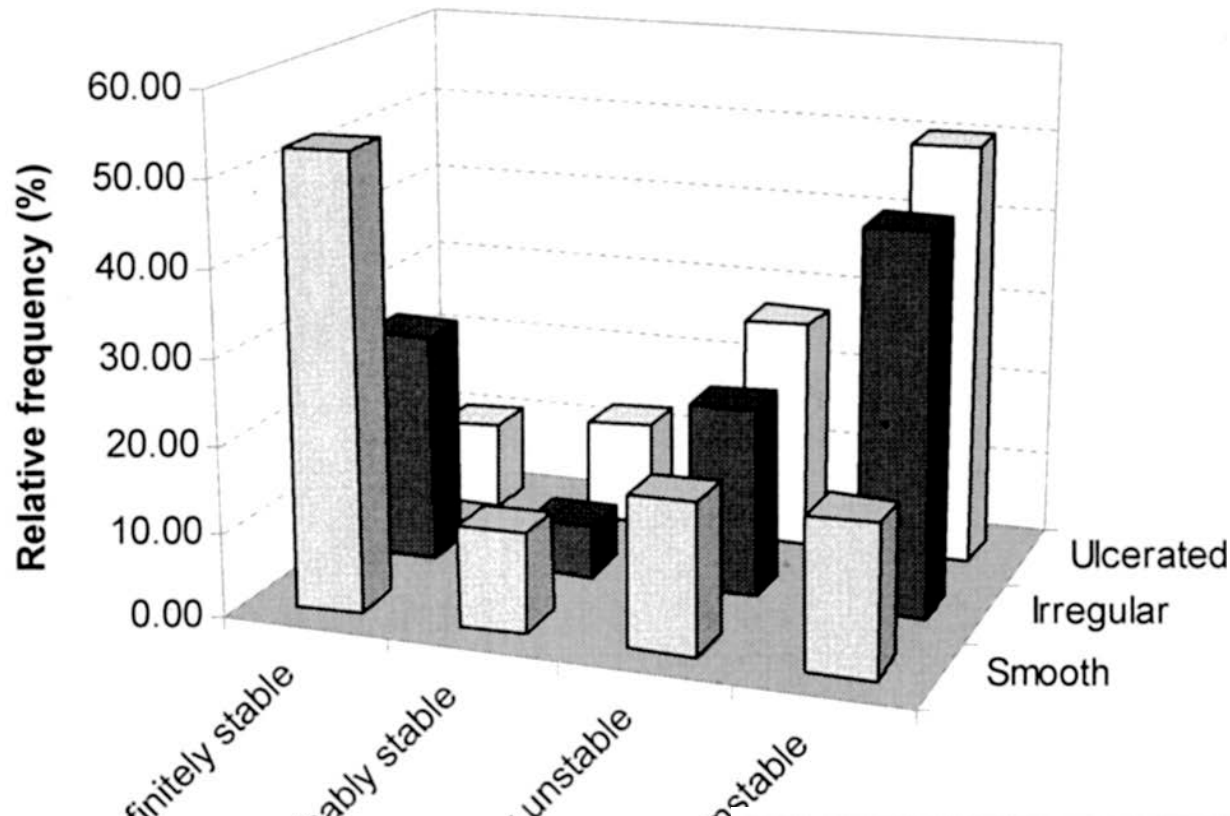
**Ulcer type 4:** Ulcer neck is distal and main part of ulcer points proximally.

**Types of irregularity** (not considered to be ulcers for this study)

a) Pre or post stenotic dilatation

b) Wall irregularities may represent a normal lumen between two or more smooth plaques

# Plaque instable vs plaque stable morphologie de la sténose

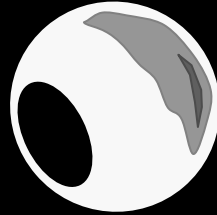


Histological grade of overall plaque instability

Angiographic appearance	Definitely stable	Probably stable	Probably unstable	Definitely Unstable	Totals
Smooth	9 (53%)	2 (12%)	3 (18%)	3 (18%)	17 (100%)
Irregular	17 (27%)	4 (6%)	14 (22%)	28 (44%)	63 (100%)
Ulcerated	5 (10%)	6 (13%)	13 (27%)	24 (50%)	48 (100%)
Totals	31	12	30	55	128

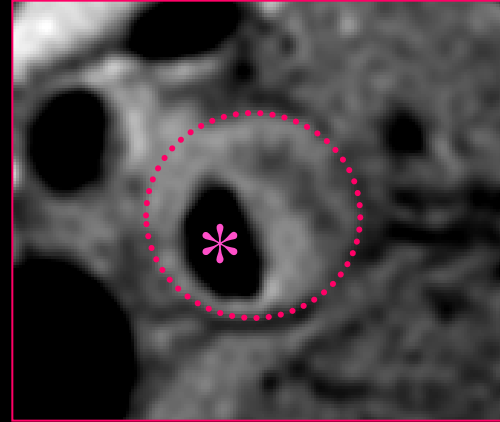
# Plaque instable vs plaque stable

## Exemple de la plaque coronaire



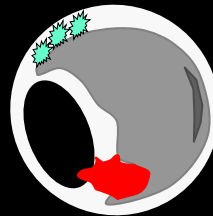
- *Stable*

- Chape fibreuse: épaisse
- Coeur lipidique: petit
- Tissu fibreux + + +



- *Instable*

- Chape fibreuse: fine ou rompue
- Coeur lipidique: Large
- Hémorragie
- Tissu fibreux
- Ulcération







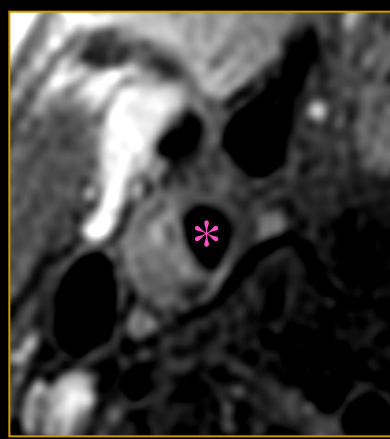
# IRM de la plaque carotide



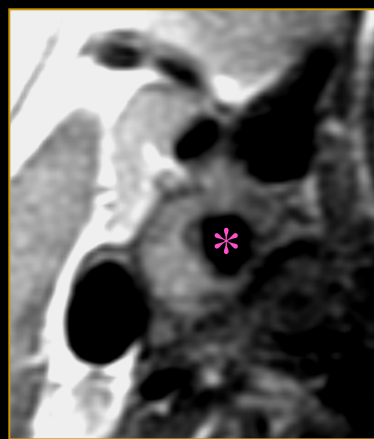
- Antenne de surface
- Imagerie multiparamétrique



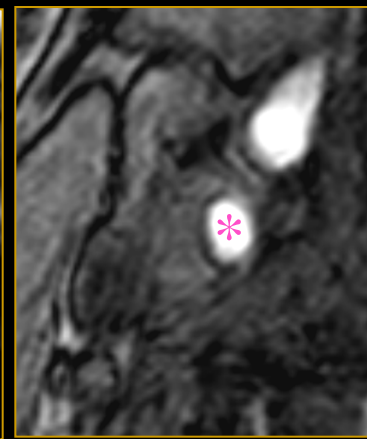
PD



T2



T1



Time of flight

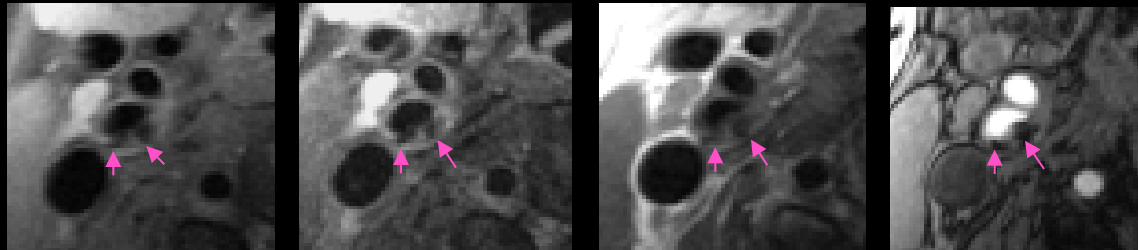


**BLACK BLOOD**

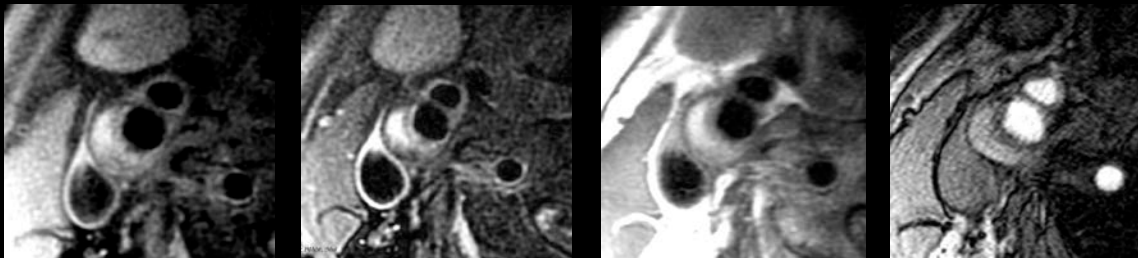
**WHITE BLOOD**

# Sémiologie et composition de la plaque

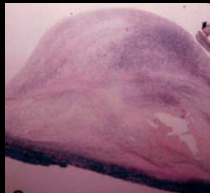
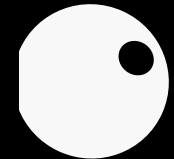
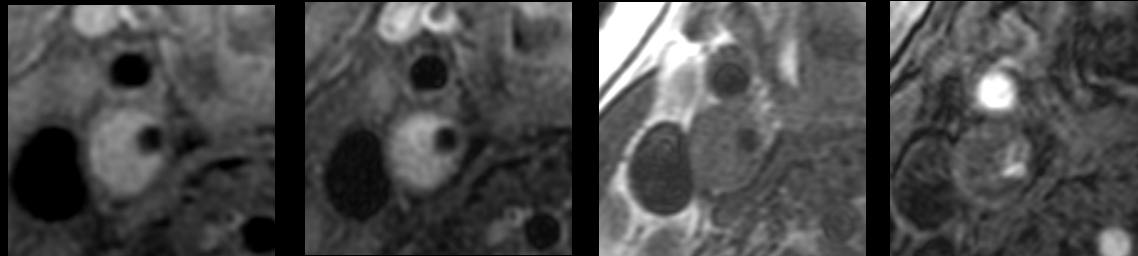
Calcium



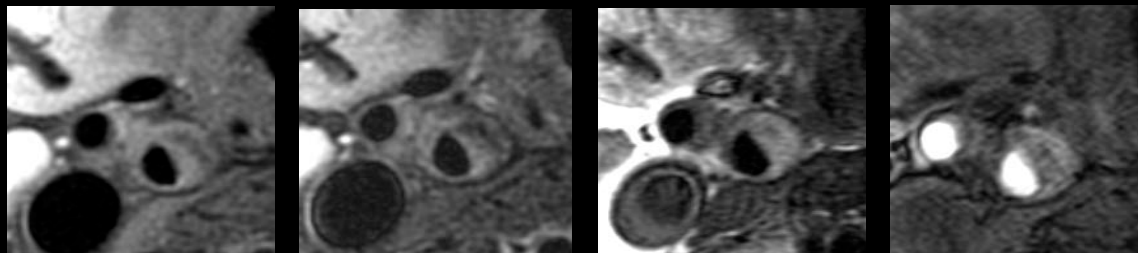
Hémorragie



Fibreux



Cœur lipidique



PDw

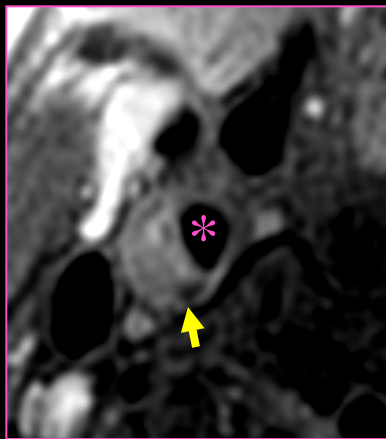
T2w

T1w

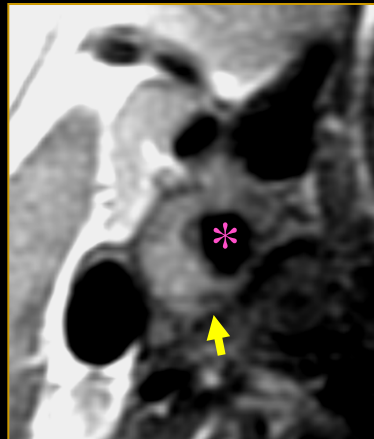
TOF



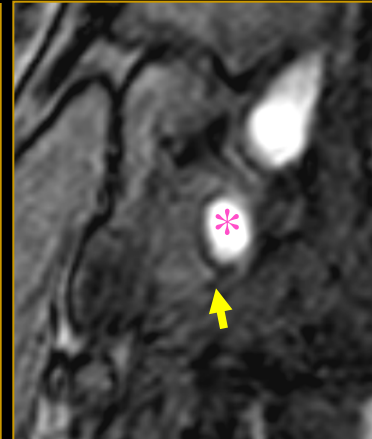
DP



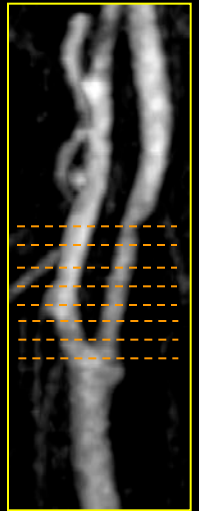
T2







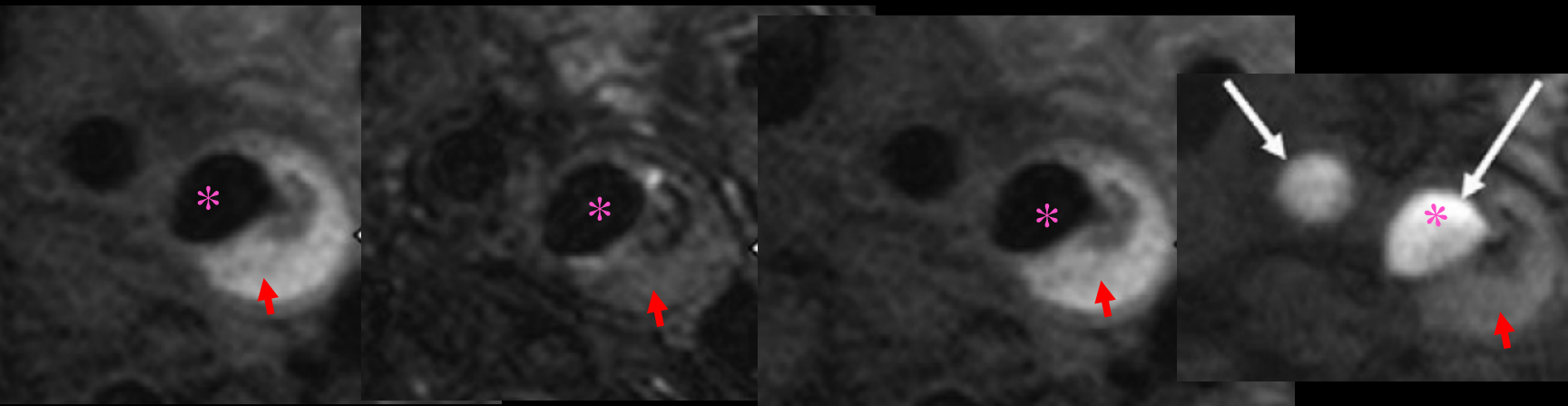
T1



Time of flight



-  Lumière
-  Calcium
-  Lipides
-  Fibreux



T1

T2

T1+

Time of flight

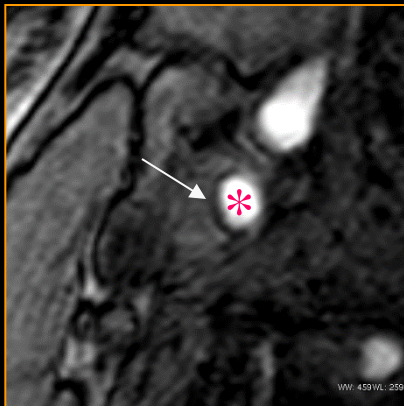


-  Lumière
-  Lipides
-  Hémorragie
-  Fibrous

# Chape fibreuse



Ligne hypointense en TOF



Continue  
Épaisse

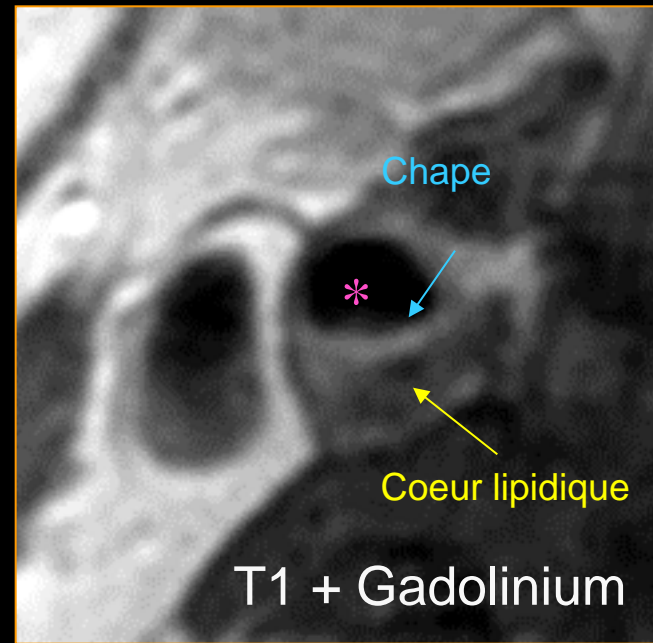
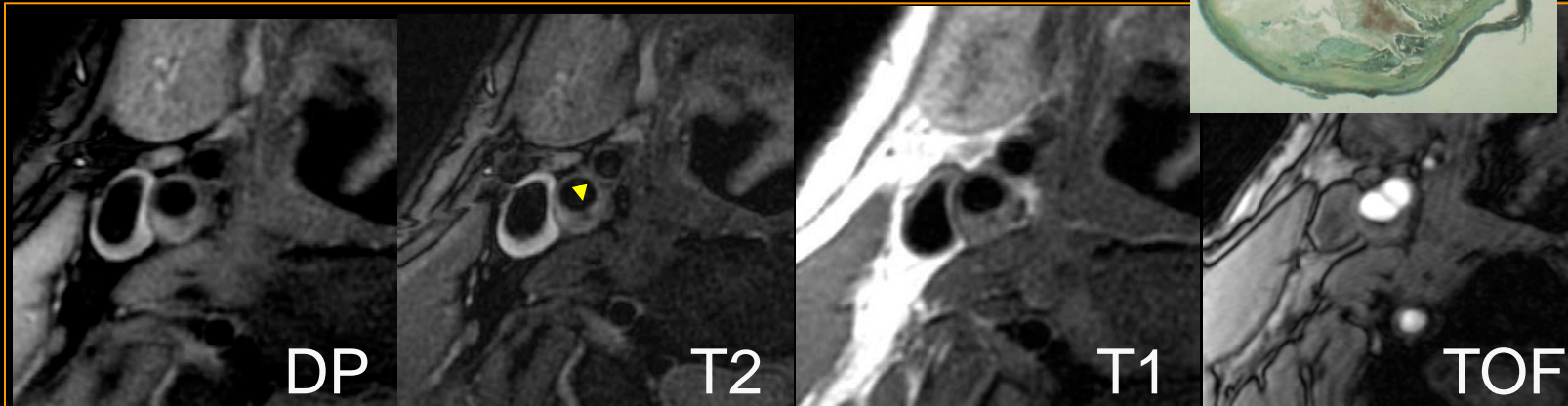


Non visible  
fine



Rompue

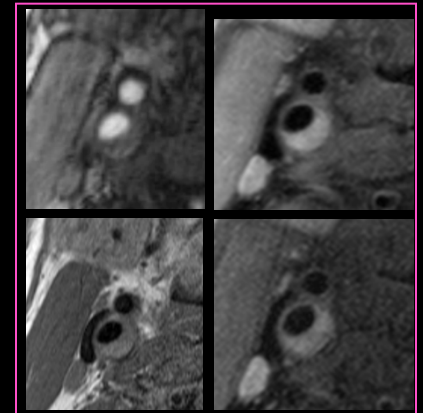
# Chape fibreuse



From the HIRISC study

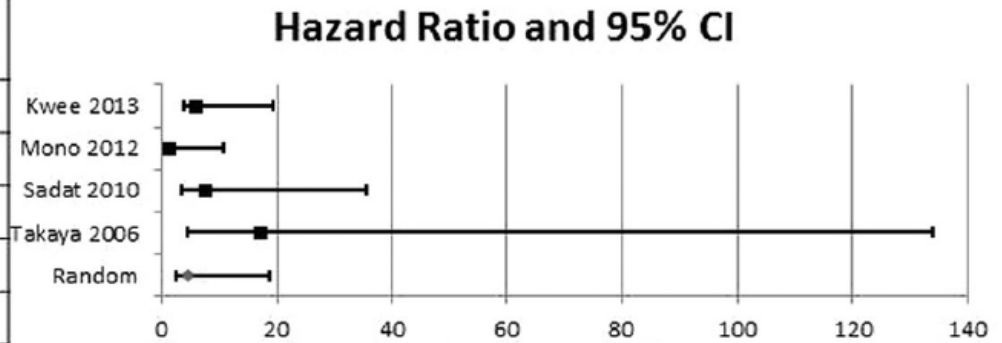
# Études pronostiques

- ✓ Sténoses asymptomatiques (50-99%)
- ✓ Sténoses symptomatiques (30-69%)
  - o Hémorragie  
7 études, 3 *NS*
  - o Chape rompue  
4 études, 2 *NS*
  - o Cœur lipidique  
4 études, 1 *NS*



# Un large cœur lipidique est-il un facteur de risque d'AVC-AIT ?

	Study Name	HR	Lower Limit	Upper Limit	P-Value
All LNRC Studies	Takaya 2006	4.40	0.587	32.973	0.1490
	Sadat 2010	1.75	0.551	5.554	0.3420
	Mono 2012	7.20	1.12	46.281	0.0380
	Kwee 2013	3.20	1.079	9.492	0.0360
	Random	<b>3.00</b>	<b>1.511</b>	<b>5.945</b>	<b>0.0020</b>

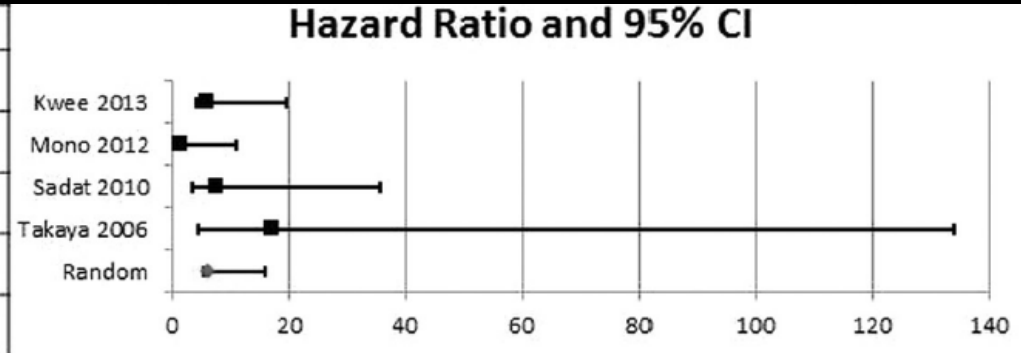


**Hazard Ratio : 1.5 – 6**



# Une chape fibreuse fine / rompue est elle un facteur de risque d'AVC-AIT ?

All TRFC Studies	Takaya 2006	17.00	2.195	131.671	0.0070
	Sadat 2010	7.39	1.612	33.857	0.0100
	Mono 2012	1.10	0.114	10.704	0.772
	Kwee 2013	5.80	1.926	17.465	0.0020
	Random	5.93	2.65	13.29	<0.01



## Hazard Ratio : 2.7-13.3

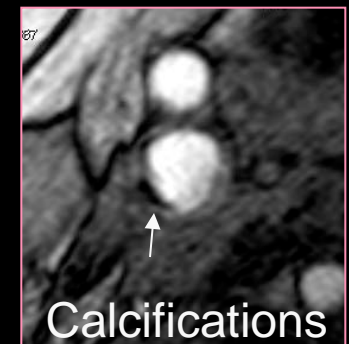
Mais :

- Calcifications juxta lumenales / hémorragie ancienne
- Reproductibilité\*\*
  - en TOF  $\kappa=0.26$  [0.06-0.47]

*Gupta A et al. Stroke 2013*

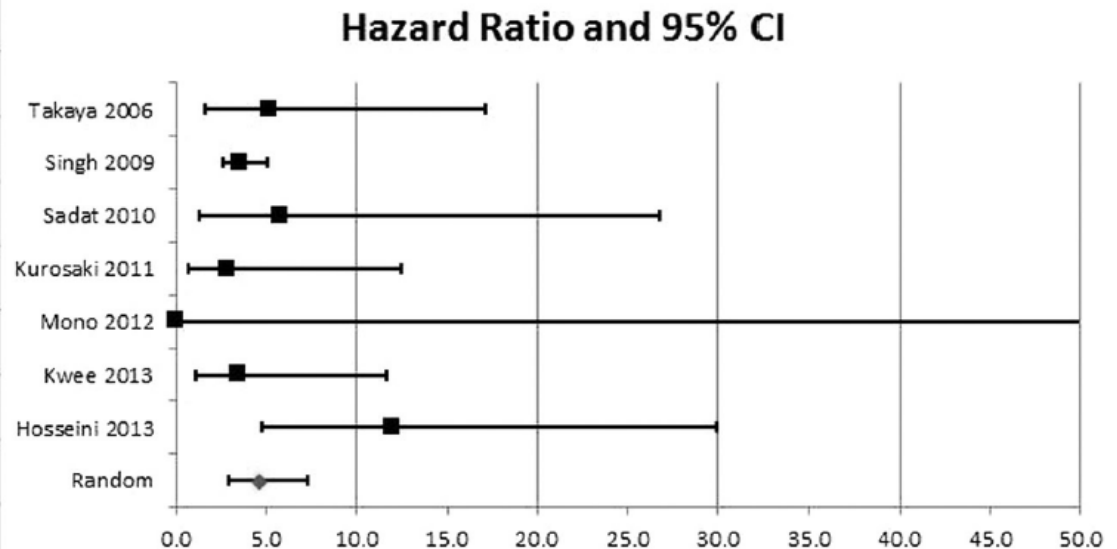
*Carotid Plaque MRI and Stroke Risk: A Systematic Review and Meta-analysis*

\*\* *Touzé et al. 2007*



# L'hémorragie intra plaque est elle un facteur de risque d'AVC-AIT ?

	Study Name	HR	Lower Limit	Upper Limit	P-Value
AllIPH Studies	Takaya 2006	5.20	1.581	17.153	0.007
	Singh 2009	3.59	2.561	5.05	<0.01
	Sadat 2010	5.85	1.286	26.794	0.022
	Kurosaki 2011	2.83	0.644	12.425	0.168
	Kwee 2013	3.50	1.043	11.684	0.043
	Hosseini 2013	12.00	4.762	29.943	<0.01
	Mono 2013	0.03	0.000	86.6	0.999
	Random	4.59	2.92	7.24	<0.01



**Hazard Ratio : 2.9-7.2**

*Gupta A et al. Stroke 2013*

*Carotid Plaque MRI and Stroke Risk: A Systematic Review and Meta-analysis*

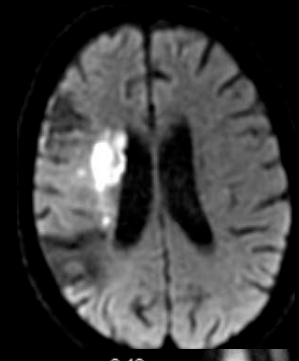
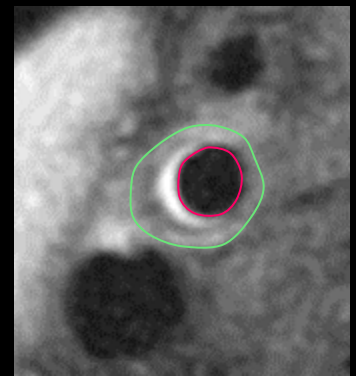
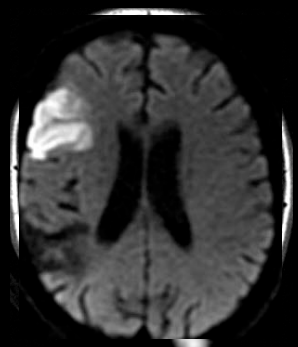
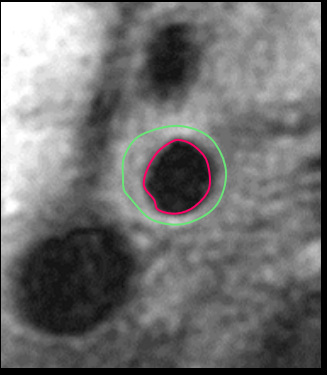
*Saam et al. JACC 2013*

IRM de plaque

+ 1 an

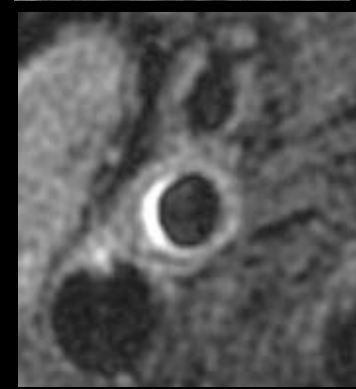
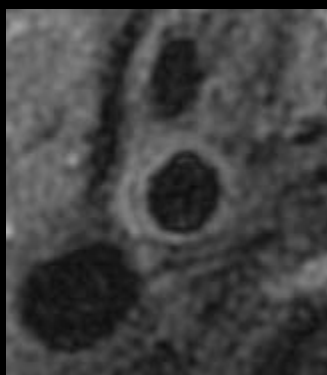
+ 1 an

DP

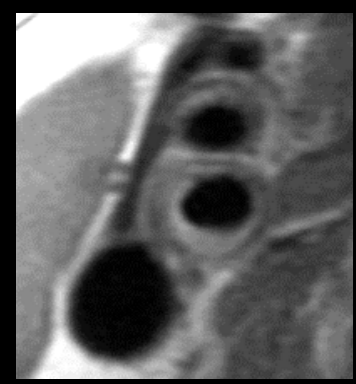
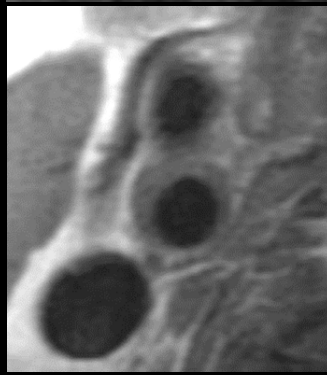


S 48

T2



T1



I 84



## Et à l'avenir ?

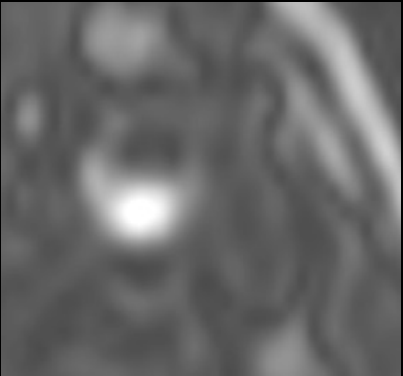
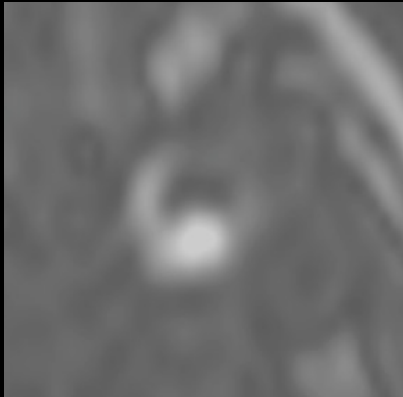
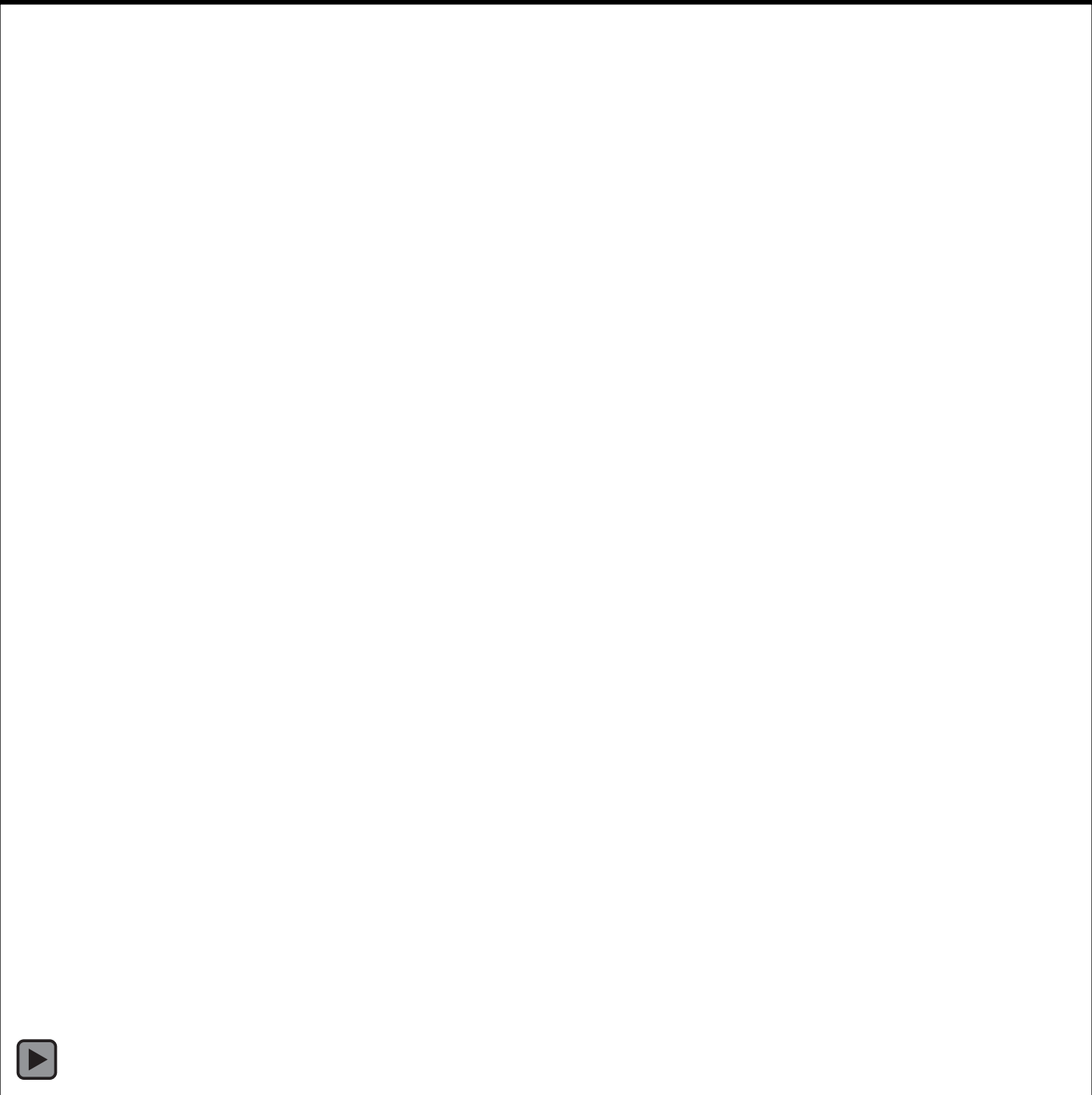
- Antenne de surface, durée d'examen  
→ limite à la diffusion de la technique  
→ antenne neck, spine, neurovasculaire <sup>1,2,3</sup>

Hémorragie intra-plaque

-1.5T antenne de surface HR=5.04

-antenne non dédiée HR=4.41

→ IRM 3T<sup>4</sup>





## Et à l'avenir ?

- Antenne de surface, durée d'examen  
→ limite à la diffusion de la technique  
→ antenne neck, spine, neurovasculaire <sup>1,2,3</sup>

Hémorragie intra-plaque

-1.5T antenne de surface HR=5.04

-antenne non dédiée HR=4.41

→ IRM 3T<sup>4</sup>



## CONCLUSION

- IRM de plaque outil d'identification des patients pour inclusion dans RCT
  - Sténose symptomatique <70%
  - Sténose asymptomatique 60-99%
- Exemple *PHRC national 2014 ACTRIS*  
Sténose asymptomatique % AIT-AVC : 0.5%/ an
  - Inclusion de milliers de malades
  - N'inclure que si hémorragie intraplaque