

## Multilayer Flow Modulator (MFM®) implant :

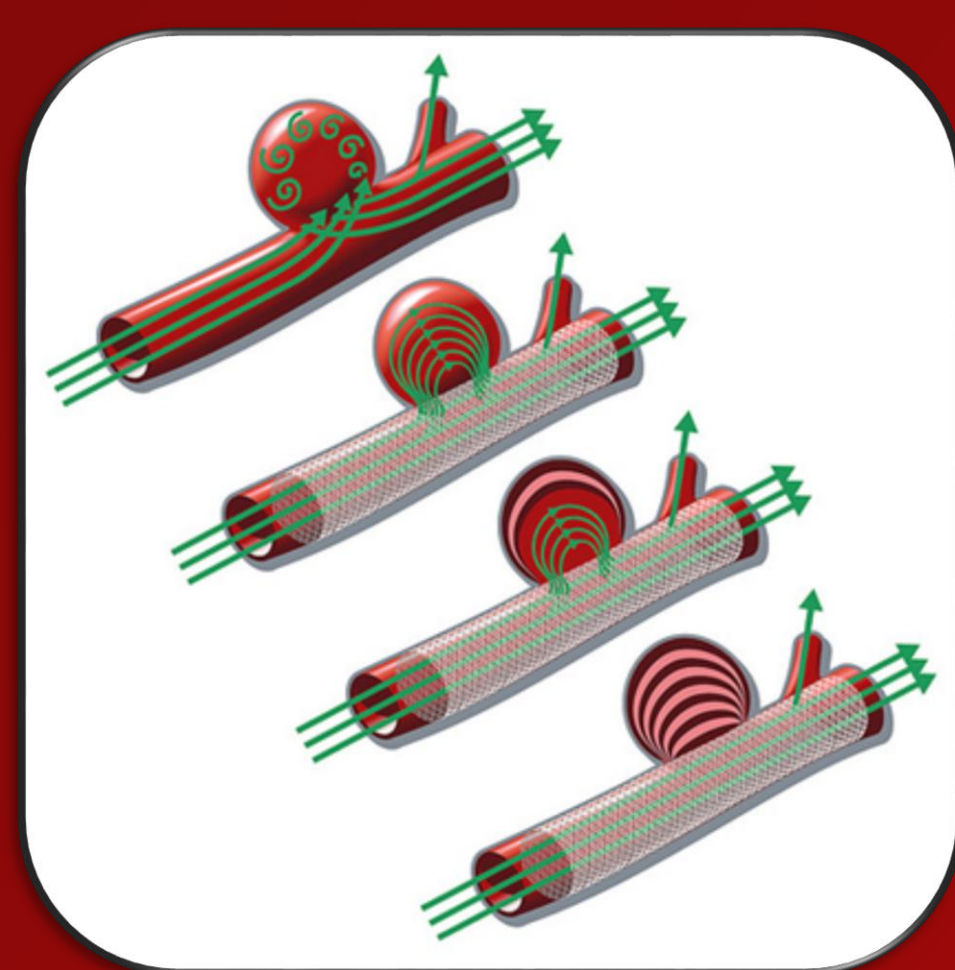
Stents, mesh and tubular devices, are commonly used in the support of natural cavities, mainly vascular and urinary. In this context, Cardiatis (Belgium) offers a multilayer flow modulator implant (MFM®).

This system, due to its three-dimensional structure, offers a porosity ensuring the irrigation of the collateral branches along this device. In addition, it does not exclude the aneurysm from the bloodstream and transform the turbulent flow into a laminar flow.

The absence of stress caused by shear forces along the wall of the aneurysm therefore reverses the degenerative process of the aneurysm and significantly reduces the risk of rupture. The installation of an MFM® implant induces a laminar flow favoring the formation of a thrombus organized in stratified layers, resulting from the lines of Zahn.



MFM® Implant



Formation of a laminar flow and Zahn lines following the installation of an MFM® implant (Cardiatis ©)

This implant plays a major role in the treatment of aneurysms. It allows to model the artery and also the blood flow by creating a laminar flow while ensuring an optimal irrigation of collaterals

## Aneurysm model :

The development of the aneurysm can be induced via different procedures but in order to obtain precise localization and good reproducibility, we selected a surgical approach. It targets the abdominal aorta, on of the most common place of aneurismal formation in humans.

In order to be able to trigger the formation of aneurysm, the abdominal aorta is disengaged so that a gauze impregnated with 0.5M CaCl<sub>2</sub> can be applied to its periphery.

This treatment is intended to cause external damage to the artery, promoting inflammation as well as an arteriosclerotic reaction of the adventitia and subsequent formation of aneurysm.



Isolation of the abdominal aorta and peripheral treatment

This technique, known for its good results and its reproducibility, makes it possible to ascertain the location of the aneurysm formation (Tanaka A. et al, 2009). The formation of an aneurysm takes 2 to 3 weeks, after which the animal will receive a multilayer flux modulator or not to establish the different groups of animals.

## Rodent model :

Hypertension is a risk factor playing an important role in the development of aneurysm and in the risk of rupture [1] due to the turbulent flow and the increase in blood pressure it causes. Therefore, in order to promote the development of the aneurysm, to best mimic the pathology and to obtain a signature really related to the modulatory effect of flow of the implant, the spontaneously hypertensive rats (SHR) was preferred in our study.

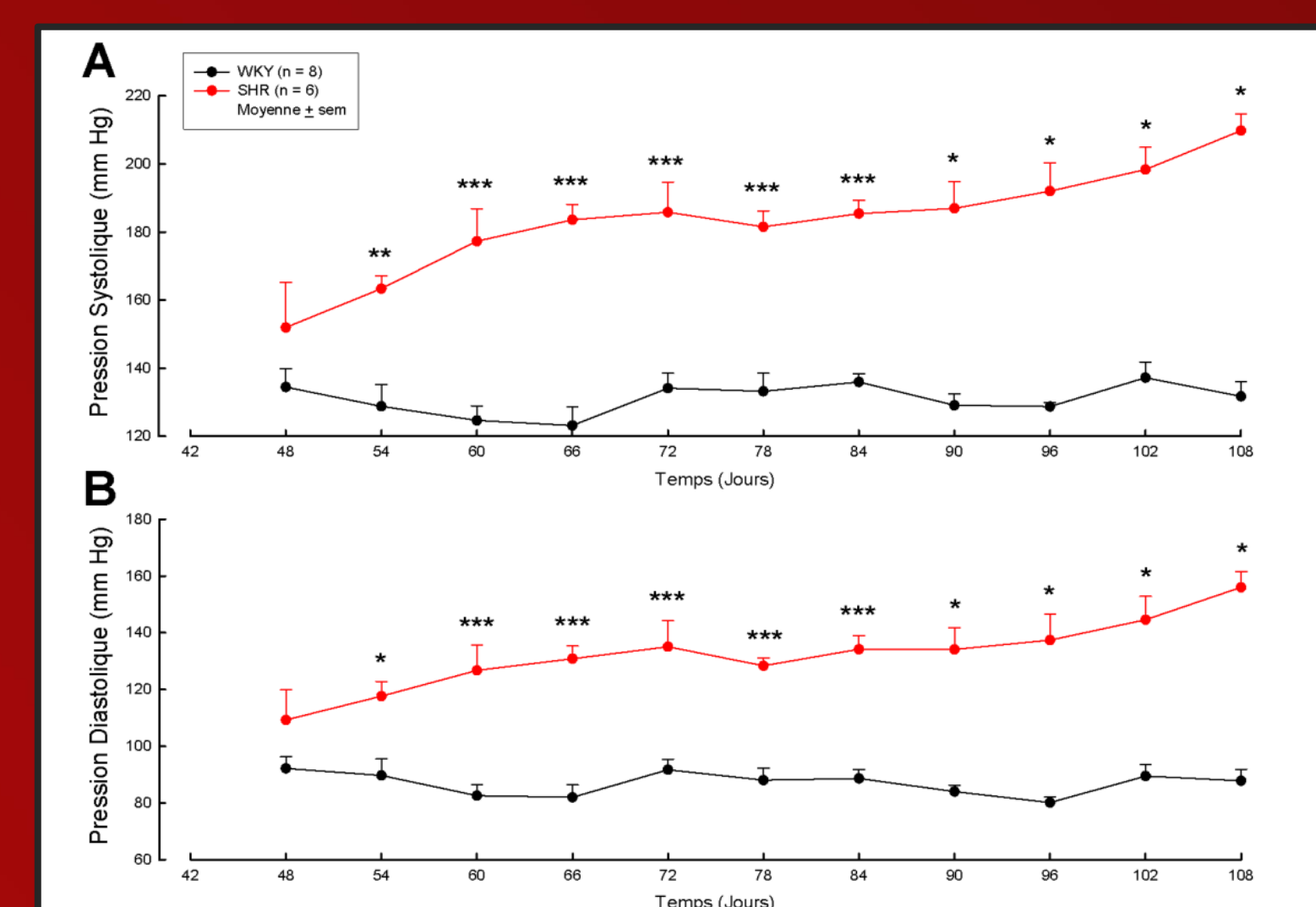
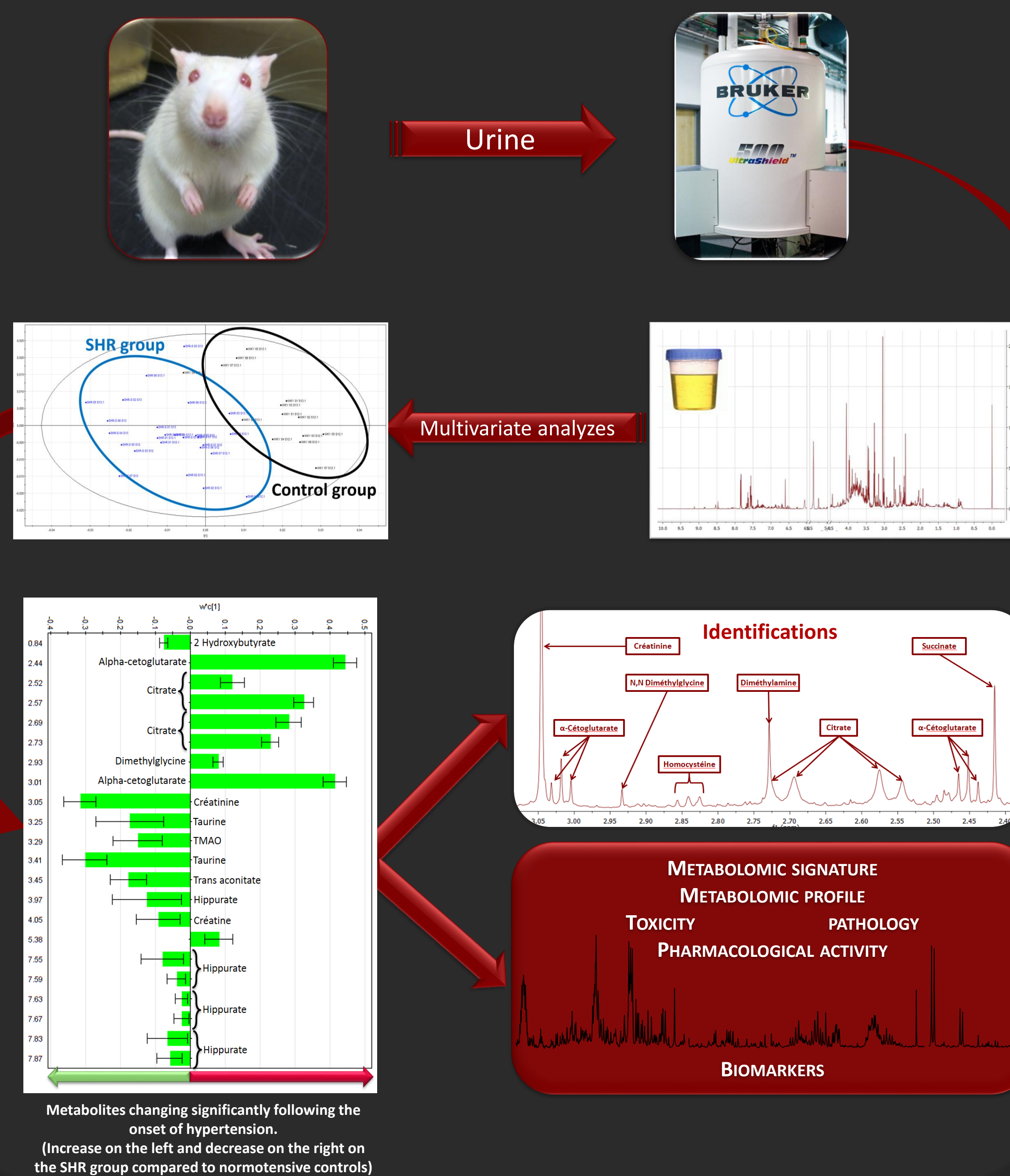


SHR rat

## SHR rat :

This rat strain has spontaneous hypertension with a systolic blood pressure of more than 150 mmHg and persisting for more than one month. This hypertension begins to develop spontaneously from the sixth week of life.

## Metabolomics :



Graph showing the evolution of systolic (A) and diastolic (B) pressures over time (age of rats in days) between WKY rats (in black) and SHR rats (in red).  
[Wilcoxon; \* = p-value <0.05, \*\* = p-value <0.01, \*\*\* = p-value <0.001]

## Hypertension signature :

TMAO, allantoin and taurine levels are varying according to the literature during the onset of hypertension. Indeed, TMAO urinary level is an indicator of the onset of hypertension. This osmolyte has an important effect on hemodynamic response against angiotensin II [3].

As a result, the decrease in allantoin may reflect its arterial tension regulator effect, opposed to the onset of hypertension [4].

As shown by Akira and al [5], taurine exerts a significant stabilisation effect on blood pressure in SHR rats. Its increasing level could be related to a physiological response to the onset of hypertension.

Finally, levels of citric acid intermediates are decreasing following the onset of hypertension. These changes would reflect a mitochondrial attack by the release of reactive oxygen species.

## Aneurysm signature:

The development of the pathology and its return to normal are currently followed by the metabonomic approach on different biofluids such as urine, blood and cell extractions of aortic sections. The consequences of the placement of this new type of implant will then be assessed using the same approach.

## References :

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- 3, Ufnal, M. and al. TMAO, a carnitine-derived metabolite, prolongs the hypertensive effect of Ang II in rats. *Canadian Journal of Cardiology*. 2014
- 4, Chen, M.-F. and al. Antihypertensive action of allantoin in animals. *Biomed Res int* 2017, 690135.
- 5, Akira, K. and al. Metabonomic study on the biochemical response of spontaneously hypertensive rats to chronic taurine supplementation using (1)H NMR spectroscopic urine analysis. *J Pharm Biomed Anal* 85, 155-161. 2013