

XXXI° PhD Course Bioengineering and Medical-Surgical Sciences

Title:

Development of a novel technology platform for
thoracoscopic aortic valve replacement

Candidate:

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Abstract

Aortic stenosis (AS) still remains the most frequent valve pathology requiring surgical intervention. Moreover it is progressive, potentially life-threatening, valve disorder with a prevalence that increase with age [1-2]. After the onset of symptoms, the average life expectancy of individuals with AS decrease, unless interventional treatment is provided. [3].Surgical aortic valve replacement (AVR) or transcatheter aortic valve implantation (TAVI), for patients with severe symptomatic AS who are not considered suitable for surgery, improves survival and quality of life [4]. Nowadays, due to constant aging of the population, this kind of patients presented at the time of surgery with more comorbidity and higher surgical risk [5]. This changing in quality of cardiac surgery patients led surgeons to move on, looking for new tools and techniques to obtain maximum reducing risks.

During the last three years of PhD program in Bioengineering and Medical-Surgical Sciences the core of the research was aimed to find innovative solutions in aortic valve surgery in terms of minimal invasive technique, in order to reduce the impact of traditional surgery in treatment of this kind of pathology.

The research was aimed to analyse the overall problem starting from diagnosis, passing through studying new valve prosthesis potentiality and limitations and finally looking for new technologies that can help surgeons in this type of valvular pathology.

So we conducted several studies on different issue of aortic valve stenosis.

First, as previously said, the impact of aortic stenosis in the population is changing. Nowadays, there are few information regarding the management and the pathways of patients with aortic stenosis. For this reason, we accepted to participate and collaborate to IMPULSE registry. IMPULSE registry is a multicentre, multinational (across Europe),

observational study. The aim of this registry is to well define contemporary aspects of aortic stenosis and how it is managed in an era of profound changes in aortic valve replacement. This registry give us a clear snapshot of contemporary situation. The results are very interesting and show many aspects that require research and a more in-depth analysis of the problem.

Furthermore, not only aortic stenosis management is changing in treatment (AVR vs TAVI), but also in surgical field there are new kind of prosthesis that change some point of view in surgical approach of the pathology. In the last decade, cardiac surgery was subsequently revolutionized following the introduction of nitinol-based sutureless prostheses for aortic valve replacement (AVR). This new prosthesis carried out new problems [6]. One of these is the major development of conduction disorder after prosthesis implantation. With this retrospective study, we wanted to clarify and identify if there were some conditions that could be lead to pacemaker implantation [7-8].

Extracorporeal circulation (ECC) remains a necessary instrument for cardiac surgery. For this reason we try to analyse the problem from two different points of view, looking for minimize the impact of ECC. First, we participate to an international randomized study in using minimal ECC (MiECC) named COMICS (Conventional versus Minimally Invasive extra-corporeal circulation in patients undergoing Cardiac Surgery). This registry try to explore and define better outcomes in using particular miniaturized system of ECC [9]. On the other hand, we designed a single centre randomized trial in using pulsatile flow instead of continuous one in some particular kind of patients and in define surgical interventions as aortic valve replacement.

Finally, the core of PhD research was to find and develop new instruments that can help surgeons approaching minimal invasive aortic valve surgery. For this reason, we try to apply ultrasonic technology for calcium debridement [10-11]. Ultrasonic vibrations destroyed and remove calcium from soft tissues without damage them. In fact at particular

frequencies, soft tissues vibrate concurrently without damage instead of hard tissue as bone or calcium that are removed by the ultrasonic movement. We identify a particular kind of instrument, already used in other surgeries, that can meet our needs. This is a particular probe that, in our opinion, could be very useful in calcium removal especially in minimal invasive aortic valve surgery.

References

- 1- Eveborn, Gry Wisthus, et al. "The evolving epidemiology of valvular aortic stenosis. the Tromsø study." *Heart* 99.6 (2013): 396-400.
- 2- Maganti, Kameswari, et al. "Valvular heart disease: diagnosis and management." *Mayo Clinic Proceedings*. Vol. 85. No. 5. Elsevier, 2010.
- 3- Schwarz, Franz, et al. "The effect of aortic valve replacement on survival." *Circulation* 66.5 (1982): 1105-1110.
- 4- Van Geldorp, M. W. A., et al. "The effect of aortic valve replacement on quality of life in symptomatic patients with severe aortic stenosis." *Netherlands Heart Journal* 21.1 (2013): 28-35.
- 5- Osnabrugge, Ruben LJ, et al. "Aortic stenosis in the elderly: disease prevalence and number of candidates for transcatheter aortic valve replacement: a meta-analysis and modeling study." *Journal of the American College of Cardiology* 62.11 (2013): 1002-1012
- 6- Khatri PJ, Webb JG, Rodés-Cabau J, et al. Adverse effects associated with transcatheter aortic valve implantation: A meta-analysis of contemporary studies. *Ann Intern Med* 2013;158:35-46
- 7- van Boxtel AG, Houthuizen P, Hamad MA, et al. Postoperative conduction disorders after implantation of the self-expandable sutureless Perceval S bioprosthesis. *J Heart Valve Dis* 2014;23:319-324
- 8- Hoffmann R, Herpertz R, Lotfipour S, et al. Impact of a new conduction defect after transcatheter aortic valve implantation on left ventricular function. *J Am Coll Cardiol Cardiovasc Interv* 2012;5:1257-1263
- 9- Anastasiadis K, Antonitsis P, Haidich AB, Argiriadou H, Deliopoulos A, Papakonstantinou C. Use of minimal extracorporeal circulation improves outcome after heart surgery; a systematic review and meta-analysis of randomized controlled trials. *Int J Cardiol* 2013;164:158-69
- 10- Craver JM: Aortic valve debridement by ultrasonic surgical aspirator: a word of caution. *Ann Thorac Surg* 1990, 49:746-52
- 11- Cosgrove DM, Ratliff NB, Schaff HV, Edwards WD: Aortic valve decalcification: history repeated with a new result. *Ann Thorac Surg* 1990, 49:689-90.

