Present and Future of Urinary Stents

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1 Introduction

Urinary catheters or stents are medical devices widely used in daily urological practice. Their indications are widespread, although they are mainly used to allow internal drainage of urine, either at the ureteral or urethral area. Its use as an internal scaffold is also widely used in patients to promote both first and second intention healing at the urinary tract, after a large number of surgical techniques. It is also widely used in oncology patients to mitigate extrinsic compression and obstructive uropathy, in which case both plastic stents and mainly metallic stents are used. The metal stents have a greater mechanical strength to compression and provide a more appropriate drainage than plastic stents.

Their use is currently very common, reaching more than 80% in patients who have undergone endourological intervention for the resolution of renal or ureteral lithiasis [1]. This gives us an idea of its implantation in lithiasis disease which, as is well known, is increasing its appearance due to the change in dietary habits of the population, mainly in Western countries, although the rates in countries such as China have increased significantly in the last two decades [2].

Unfortunately, urinary stents are associated with high rates of side effects and complications that significantly decrease the quality of life of patients [3]. Therefore, despite their evident usefulness in urological clinical practice, their use should be subject to an important medical evaluation to balance the benefits against the side effects, as well as the possible complications associated with current urinary stents.

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F. Soria et al. (eds.), *Urinary Stents*,
https://doi.org/10.1007/978-3-031-04484-7_1

More than 80% of patients with ureteral stents have significant adverse effects affecting their quality of life, sex life and compromising their labor life [4]. In the case of metallic, ureteral or urethral stents, despite the improvements in design and biomaterials that have appeared in the last decade, their use is essentially reduced to oncological patients with short life expectancy [5]. In the latter case, that of metallic stents in urology, their residual use differs from the widespread and successful use of metallic stents in areas such as cardiology or vascular diseases. This huge difference between such similar devices in different anatomical regions is related to two aspects that differentiate both areas of knowledge, on the one hand, the resources devoted to research and on the other hand, the peculiarities that differentiate the blood vessels of the urinary tract. With regard to the peculiarities of the urinary tract, the first major difference between blood and urine is its relationship with biomaterials. Due to the use of anticoagulants, the interactions of the components that make up the blood with the biomaterials that make up the stent are significantly reduced. Another factor that differentiates the side effects of vascular stents from urinary stents is the fact that vascular stents tend to be endothelialised, thus ceasing to act as a foreign body, a circumstance that is not common in the urinary tract. The presence of ureteral or urethral peristalsis is perhaps one of the major pitfalls associated as a primary cause of failure in urinary metallic stents, a complication that does not occur in the vascular system, although it does in the digestive tract. This peristalsis causes a high migration rate and the appearance of urothelial hyperplasia that can become obstructive [6]. Another cause of the differences in stent deployment and success rate is the common urinary bacterial contamination, with a 100% probability of developing a biofilm on the stent surface and thus developing encrustations that can become obstructive. Although several modifications of the stent surface to reduce biofilm formation and bacterial colonization have been investigated at the moment no available biomaterials or coatings have been proven to prevent or reduce biofilm formation to a clinically relevant extent [7].

If we define biocompatibility as, the utopian state where a biomaterial presents an interface with a physiological environment without the material adversely affecting that environment or the environment adversely affecting the material. From the perspective of a biologic environment affecting the biomaterial, there are currently no biomaterials used in the urinary tract that are perfectly biocompatible. Unfortunately, urine as a liquid so saturated with salts creates a perfect storm, with a hostile environment for the implantation of biomaterials and the prolonged exposure to the urinary environment is not favourable to diminish their effects.

So, given the clinical requirement for the use of urinary stents and their clearly unacceptable adverse effects, the need to improve these medical devices and the research to do so is understandable. Firstly, a great technological development is needed to meet the needs of both patients and urologists for more effective medical devices with fewer associated side effects [8].

2 ENIUS Network

This is the main objective of this manuscript which arises from a European initiative supported by the COST Actions. It is clear that research in this area of knowledge has several limitations that have led to a slowdown in the innovation of urinary stents. Therefore, the creation of a European network dedicated to bring together different groups interested in urinary stents was the first step to break the slow trajectory of research in this medical device. ENIUS, European Network of Multidisciplinary Research to Improve the Urinary Stents, was born in 2017 with the aim of addressing the improvement of stents from a multidisciplinary point of view. We are aware that it is from this type of approach that progress can be made, since urinary stents need such different visions for their improvement as clinical urology, the industrial partners themselves, but also researchers in biomaterials or coatings, researchers in fluid dynamics, or microbiologists due to the permanent relationship between micro-organisms and stents and the urinary microbiome itself complete a plethora of researchers willing to improve stents. Therefore, bringing together so many ways of approaching the same problem can only generate knowledge. Another aspect to overcome in this field of knowledge is the great fragmentation of existing groups, which only leads to isolation. Cooperation between groups benefits everyone involved, as it allows the strengths of each group to be shared and the weaknesses of each group to be mitigated by other groups. The fact of being a multidisciplinary and cooperative network has allowed all participants to grow, to train young researchers who are aware of this important question and its social repercussions. Above all, it allows us to trust that the seed of innovation and development of new stents is in good hands, which benefits patients. It should not be forgotten that the aim of all research is to improve the lives of patients [9].

3 Conclusions

This book brings together the experience and expertise in urinary stents of the leading researchers in urinary stents. Not only because it addresses the present of urinary stents from a clinical point of view, but also because it includes the most innovative groups and future approaches.

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