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NEW ROBOTIC PLATFORM FOR FLEXIBLE URETEROSCOPY: DEVELOPMENT AND SIMULATION BASED TRAINING

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Abstract: Introduction: Indications for the treatment of kidney stones using flexible ureteroscopy have increased significantly in recent years, associated with the increase in the number of urologists trained to perform this procedure. However, this surgery is long and tiring for the surgeon, especially in more complex cases of renal lithiasis, leading to a loss in the surgeon's ergonomics.
Objectives: Therefore, a technological innovation was devised with the development of a prototype robotic system platform, to adapt to most commercially available flexible ureteroscopes and simulate the movements of human hands when manipulating flexible ureteroscopes, with greater ergonomics and comfort for the urologist and favoring the training of residents in urology.
Materials and Methods: The prototype consists of two elements: the flexible ureteroscope fixation platform and the surgeon's console. The robotic platform has mechanisms controlled by motors that perform the movements of the flexible ureteroscope: flexion and deflection, rotation and advancement in the renal pelvis. The console is portable and has a video monitor, controlling the movements of the ureteroscope using the joystick. The robotic platform was developed at a cost of less than \$10,000.
For surgical training with this new robotic platform, a synthetic human model will be used for simulation and training of residents on our team.
The robotic simulation procedures will use a synthetic human model, where six residents underwent training in five simulated surgeries, with three 5 mm fragments of calcium carbonate, simulating kidney stones, being positioned in the upper, middle and lower calyces of the kidney.
Results: The simulated surgical procedure using the robotic platform was successful, being tested individually by six residents and after the third resident training session, a significant improvement was demonstrated in the simulation stages of the surgical procedure, with fragmentation of all calculations and reduction of procedure time.
Conclusions: The universal robotic platform for flexible ureteroscopic surgery was initially developed for training in kidney stone treatment. This mechanism is low cost when compared to similar robotic mechanisms already in use and can be used for the training of residents and urologists who are improving their skills in robotic flexible ureteroscopy surgeries, also providing good ergonomics for the surgeon.
Keywords: Flexible Ureteroscopy, Simulation, Robotic, Kidney Stones, Ureteroscopy.

INTRODUCTION

Indications for the treatment of kidney stones, using a flexible ureteroscopy surgical procedure, have increased significantly in recent years, mainly due to the greater precision and durability of flexible endoscopic equipment. Also, there has been an increase in the number of urologists trained to perform this procedure. However, this surgery is long and tiring for the surgeon, especially in more complex cases of renal lithiasis, leading to a loss in the surgeon's ergonomics [1].

Robot-assisted surgical procedures, in minimally invasive surgeries, have developed in recent years and are based on the introduction of console-based manipulators that simulate hand movements, improving ergonomics and the surgeon's technical quality.

The robotic laparoscopic surgery system was initially developed with "Da Vinci Surgical Systems" (Intuitive Surgical, Sunnyvale, CA, USA) [2]. Desai and colleagues used the Hansen device, (Hansen Medical, Mountain View, CA, USA) [3-5] designed for cardiovascular interventions, to perform robot-assisted flexible ureteroscopy [4,5], however, this design was discontinued. Since 2012, ELMED (Ankara, Turkey) has successfully developed a robot designed specifically for robot-assisted flexible ureteroscopy [6], "Avicenna Roboflex", which facilitates endoscopic surgery via the uretera for the treatment of kidney stones [7–12].

Therefore, a technological innovation was devised with the development of a prototype robotic system platform, to adapt to most commercially available flexible ureteroscopes and simulate the movements of human hands when manipulating flexible ureteroscopes, with greater ergonomics and comfort for the urologist. being portable, easy to assemble in the operating room, taking up little space in the operating room and also favoring the training of residents in urology.

MATERIAL AND METHODS

The prototype consists of two elements: the flexible ureteroscope fixation platform and the surgeon's console.

The development of the universal robotic platform for fixing ureteroscopes (fig.1) has manipulation mechanisms using remotely controlled motors that perform movements: flexion and deflection, rotation and advancement in the renal pelvis of the flexible ureteroscope.

The platform has a mobile base, with an adjustable fixing mechanism, which allows the endoscope to be kept in sterilized conditions during the surgical procedure.

The console is portable, weighing less than three pounds and has two mechanisms for controlling the platform. The first allows the flexion and deflection of the tip of the ureteroscope and the second mechanism allows the rotation, advancement and retreat of the flexible ureteroscope within the renal pelvis. The console also has a portable five-inch video monitor, which allows endoscopic visualization of the procedure in real time. Thus, the surgeon's manipulation console can be positioned comfortably at a distance from the patient, controlling the movements of the ureteroscope using the console's joystick (figs.2,3,4).

The robotic platform was developed together with a team of urologists and engineers specialized in robotics and the costs did not exceed 10,000 dollars.

For surgical training with this new robotic platform for flexible ureteroscopy, a synthetic human model will be used for simulation and training of residents on our team, so that they can qualify in the robotic flexible ureteroscopy procedure.

The robotic simulation procedures will be performed individually by six residents, in five simulated surgeries for each resident, with three 5 mm fragments of calcium carbonate, simulating kidney stones, being positioned in the upper, middle and lower calyces of the kidney.

Therefore, the risks of scientific research are minimal, since it involves the development of robotic equipment accessory to the already established flexible ureteroscopy surgery procedure for the treatment of renal lithiasis, which will be tested on a synthetic model.

RESULTS

The simulated surgical procedure was successful, with the surgeons performing delicate and precise movements with the ureteroscope inside the renal pelvis, achieving fragmentation of the urinary stones in the artificial model of the kidney, using the robotic platform.

The procedures were tested individually by six residents and after the third resident training section, there was a significant improvement in the stages of surgical procedure simulation (figs.5,6,7), with fragmentation of all calculations and reduction in operating time.

procedure.

DISCUSSION

In video surgeries, the learning curve is higher when compared to conventional surgery techniques, and the skills developed improve with training using simulators [13,14]. Structured and continuous training in surgical simulators is most important for developing the technique [15]. Surgical simulators can be divided into two large groups, those that use synthetic models, animals and humans, and those that use virtual reality devices and electronic models [16].

Their use is proven to help significantly improve the knowledge of surgical skills [17], thus, training and continuous repetition of the surgical technique leads to important improvement for the surgeon [18,13, 19].

However, there is still a low application rate of simulation in urological training, as the costs involved in developing simulators in urological robotic surgery are high and there is still difficulty in choosing the best models for the different training stages. [20]

Thus, the prototype robotic system platform for flexible ureteroscopes was designed with simple, low-cost, portable and accessible material at any time and training environment, and can be used as an important tool for training residents and urologists in this technique.

The prototype was budgeted at US$10,000, a value below conventional virtual reality models, which are currently used for training in centers specializing in flexible ureteroscopy. In addition, it provides training in an artificial model of renal lithiasis via ureteroscopy, with the possibility of an evolution of training for an animal model, using female pigs.

CONCLUSION

The universal robotic platform for flexible ureteroscopic surgery was initially developed for training in kidney stone treatment. This mechanism is low-cost when compared to similar robotic mechanisms already in use and can be used for the training of residents and urologists who are improving their skills in robotic flexible ureteroscopy surgeries, also providing good ergonomics for the surgeon.

This Brazilian technological innovation must be improved and encouraged, mainly so that the country can develop new technology hubs in the area of urology and robotic surgery.

Therefore, due to the positive results, the development of experiments with this prototype must continue to improve this robotic platform.

REFERENCES

[1] Healy KA, Pak RW, Cleary RC, Colo-Herdman A, Bagley D. Hand and wrist problems among endourologists are very common. Endourol 2011;25:1905–20.

[2] Rassweiler J, Safi KC, Subotic S, Teber D, Frede T. Robotics and telesurgery, an update on their position in laparoscopic radical prostatectomy. Minim Invasive Ther Allied Technol 2005;14:109–22.

[3] Aron M, Haber GP, Desai MM, Gill IS. Flexible robotics: a new paradigm. Curr Opin Urol 2007;17:151–5.

[4] Desai MM, Aron M, Inderbir SG, et al. Flexible robotic retrograde renoscopy: description of novel robotic device and preliminary laboratory experience. Urology 2008;72:42–6.

[5] Desai MM, Grover R, Aron M, et al. Robotic flexible ureteroscopy for renal calculi: initial clinical experience. J Urol 2011;186:563–8.

[6] Saglam R, Kabakci AS, Koruk E, Tokatli Z. How did we designed and improved a new Turkish robot for flexible ureterorenoscopy. J Endourol 2012;26(Suppl 1):A275, MP44-12.

[7] Preminger GM, Tiselius H-G, Assimos DG, et al. 2007 guideline for the management of ureteral calculi. Eur Urol 2007;52:1610–31.

[8] Beiko DT, Denstedt JD. Advances in ureterorenoscopy. Urol Clin North Am 2007;34:397–408.

[9] Breda A, Ogunyemi O, Leppert JT, Schulam PG. Flexibleureteroscopy and laser lithotripsy for multiple unilateral intrarenal stones. Eur Urol 2009;55:1190–7.

[10] Rassweiler JJ, Knoll T, Kohrmann K-U, et al. Shock wave technology and application: an update. Eur Urol 2011;59:784–96.

[11] Patel A, Fuchs GJ. Expanding the horizons of SWL through adjunctive use of retrograde intrarenal surgery: new techniques and indications. J Endourol 1997;11:33–6.

[12] Knoll T, Jessen JP, Honeck P, Wendt-Nordahl G. Flexible ureteror- enoscopy versus miniaturized PNL for solitary renal calculi of 10-30 mm size. World J Urol 2011;29:755–9.

[13] ASLAM, A.; NASON, G. J.; GIRI, S. K. Homemade laparoscopic surgical simulator: a cost-effective solution to the challenge of acquiring laparoscopic skills?. Irish Journal Of Medical Science (1971 -), [s.l.], v. 185, n. 4, p.791-796, 16 set. 2015. Springer Nature. http://dx.doi.org/10.1007/s11845-015-1357-7.

[14] Willaert W, van de Putte D, van Renterghen K, van Nieuwenhove Y, Ceelen W, Pattyn P. Training models in laparoscopy: systematic review comparing their effectiveness in learning surgical skills. Acta Chir Belg. 2013;113(2):77-95.

[15] Buckley CE, Kavanagh DO, Nugent E et al (2014) The impact of aptitude on the learning curve for laparoscopic suturing. Am J Surg 207(2):263–270

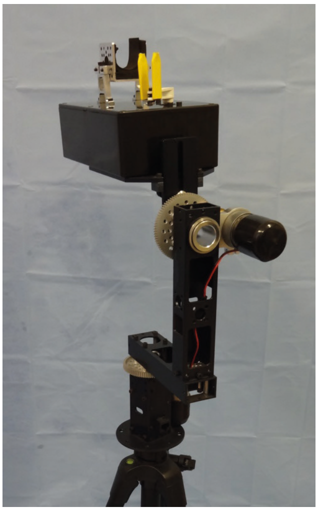
[16] Khan R, Aydin A, Khan MS, et al. Simulation-based training for prostate surgery. BJU Int 2014. [Epub ahead of print]. doi: 10.1111/bju.12721. An exhaustive overview of simulation-based training including robotic prostatectomy

[17] STEIGERWALD, Sarah N. et al. Does laparoscopic simulation predict intraoperative performance? A comparison between the Fundamentals of Laparoscopic Surgery and LapVR evaluation metrics. **The American Journal Of Surgery**, [s.l.], v. 209, n. 1, p.34-39, jan. 2015. Elsevier BV. http://dx.doi.org/10.1016/j.amjsurg.2014.08.031.

[18] Steigerwald SN, Park J, Hardy KM et al (2015) Does laparoscopic simulation predict Intraoperative performance? A comparison between the Fundamentals of Laparoscopic Surgery and LapVR evaluation metrics. Am J Surg 209(1):34–39

[19] Forster F A, Browning AJ, Paul AB, Biyani CS. Surgical simulators in urological training – views of UK Training Programme Directors. BJU Int 2012; 110:776–778.

[20] Kneebone RL, Scott W, Darzi A, Horrocks M. Simulation and clinical practice: strengthening the relationship. Med Educ 2004; 38:1095–1102.



figs. 1: universal platform

figs. 2: joystick

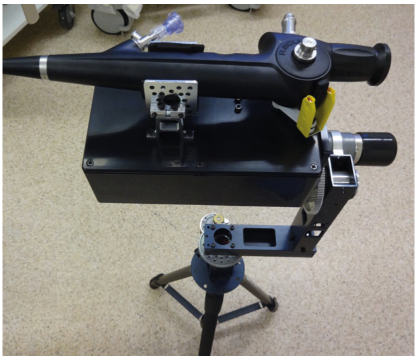


fig. 3: ureteroscope coupling in the universal platform

fig. 4: ureteroscope, endoscope camera and light cable coupling in the universal platform

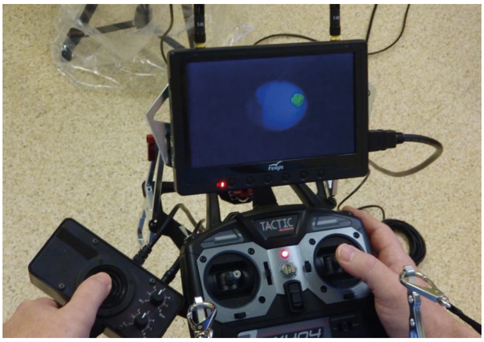


fig. 5: joystickin use

fig. 6: joystickin use

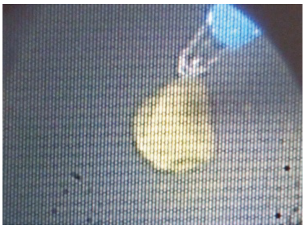


fig. 7: joystick monitorview

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