

THULIUM: YAG LASER VAPOENUCLEATION OF THE PROSTATE VS. STANDARD TRANSURETHRAL RESECTION IN BENIGN PROSTATIC HYPERPLASIA TREATMENT

Alexei PLESACOV¹✉, Vitalii GHICAVII²

¹ Republican Clinical Hospital “Timofei Mosneaga”, Department of Urology and Surgical Nephrology, State University of Medicine and Pharmacy “Nicolae Testemitanu”, Chisinau, Republic of Moldova

² Republican Clinical Hospital “Timofei Mosneaga”, Department of Urology and Surgical Nephrology, State University of Medicine and Pharmacy “Nicolae Testemitanu”, Chisinau, Moldova

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ABSTRACT

Introduction. Thulium:YAG laser has been increasingly used in retrograde transurethral enucleation of the prostate as a new advanced surgical treatment in benign prostatic hyperplasia (BPH). The implementation of Thulium:YAG laser prostatic vapoenucleation (ThuVEP) will allow patients with large BPH, who have traditionally been treated via open adenectomy or monopolar transurethral resection, to undergo minimally invasive endoscopic treatment by using laser energy.

The objective of the study was to provide a comparative assessment of ThuVEP vs. standard transurethral resection (TURP) in the treatment of benign prostatic hyperplasia.

Material and methods. The study was conducted on 81 patients with BPH, regarding the appropriate surgical treatment, including ThuVEP (40 patients) and TURP (41 patients), from May to December 2018. All patients were assessed before surgery and 3, 6 and

RÉSUMÉ

Vapoénucléation prostatique à Thulium: YAG laser vs résection transurétrale monopolaire dans le traitement de l'hyperplasie bénigne de la prostate

Introduction. L'utilisation du laser Thulium:YAG dans l'énucléation transurétrale rétrograde de la prostate peut devenir une étape avancée dans la chirurgie HPB. La mise en place de la vapoénucléation de la prostate par le laser Thulium:YAG permettra aux patients souffrant de HBP volumineuse, traités traditionnellement par l'adénomectomie classique ouverte ou la résection transurétrale monopolaire de la prostate, de suivre le traitement endoscopique minimal invasif par l'utilisation de l'énergie du laser.

L'objectif de l'étude a été l'évaluation comparative de la vapoénucléation de la prostate au laser Thulium:YAG et la résection transurétrale standard dans le traitement de l'hyperplasie bénigne de la prostate.

✉ Address for correspondence:

Alexei PLESACOV
Republican Clinical Hospital “Timofei Mosneaga”, Department of Urology and Surgical Nephrology, State University of Medicine and Pharmacy “Nicolae Testemitanu”, Chisinau, Republic of Moldova
Email: alex_pleshacov@mail.ru, Phone +37368601833

12 months after surgery. The obtained data were compared retrospectively.

Results. ThuVEP has proven its long-expected surgical efficacy. The main urodynamic and ultrasonographic indices at 12 months postoperatively showed no statistically significant difference. Moreover, the incidence rate of surgical complications was lower in the ThuVEP group. Patients from the ThuVEP group did not require further blood transfusions.

Conclusions. ThuVEP exhibited major efficacy and maximum efficiency in the treatment of BPH in our study. Thulium:YAG laser used in the surgical treatment of BPH is considered superior compared to the classic TURP endourological technique, as well as promising for clinical practice. Further long-term patients' follow-up is necessary to assess the durability of the intervention.

Keywords: laser, prostate, Thulium:YAG vapoenucleation.

Abbreviations

ThuVEP - Thulium: YAG vapoenucleation laser of the prostate;

TURP - transurethral resection of the prostate;

BPH - benign prostatic hyperplasia;

IPSS - International Prostate Symptom Score;

QoL - Quality of life score;

PSA - Prostate specific antigen;

PVR - post-void residual urine volume;

IIEF - International Index of Erectile Function 5;

Q_{mean} - the mean urinary flow rate;

Q_{max} - maximum flow rate.

INTRODUCTION

Monopolar transurethral resection of the prostate (TURP) is considered to date the gold standard surgical therapy in benign prostatic hyperplasia (BPH)¹⁻³. Its related complications and morbidity, including dysuria, blood loss, hydro-electrolytic balance disorders, water intoxication (TURP syndrome), urinary incontinence and erectile dysfunction have led to the need of implementing new technologies in treatment of BPH⁴⁻⁷. From the technological point of view, the surgical alternative use of laser energy might reduce the risks of this difficult surgical procedure and is likely to compete with TURP and classical open adenectomy⁸⁻¹⁰. The use of Thulium:YAG laser in retrograde transurethral enucleation of the prostate seems to become a new step in the surgical treatment of BPH, thus being probably the new gold standard therapy¹¹⁻¹³. The implementation of Thulium:YAG vapoenucleation laser of the prostate

Matériels et méthodes. Dans la période mai - décembre 2018, 81 patients souffrant de HBP ont fait partie d'une étude concernant le traitement chirurgical ThuVEP (40 patients) et TURP (41 patients). Tous les patients ont été évalués à l'étape préopératoire et postopératoire après 3,6 et 12 mois. Les données obtenues ont été comparées rétrospectivement.

Résultats. ThuVEP a démontré son efficacité chirurgicale espérée. Les indicateurs urodynamiques et ultrasonographiques de base, 12 mois en post-opératoire, n'ont pas eu une différence statistique significative. En même temps, le taux d'apparition des complications postopératoires dans le groupe ThuVEP a été plus bas. Les patients du groupe ThuVEP n'ont pas eu besoin de transfusion sanguine.

Conclusions. La technique de la vapoenucléation à Thulium: YAG Laser, c'est un procédé d'une efficacité importante et efficience maximale dans le traitement de HBP. L'utilisation de Thulium: Laser YAG dans la chirurgie HBP est supérieure à la technique endourologique classique TURP et est prometteuse dans la pratique clinique. La surveillance des patients à long-terme est nécessaire pour évaluer la durabilité de l'intervention.

Mots-clés: laser, prostate, vapoenucléation Thulium: YAG Laser.

(Thu-VEP) will allow patients with large BPH, who have traditionally undergone an open adenectomy or monopolar transurethral resection of the prostate, to follow a minimally invasive endoscopic treatment¹⁴⁻¹⁶.

Thulium: YAG laser is a new surgical laser with continuous emission and wavelength of 2mc that is likely to present a number of potential advantages compared to its predecessor Holmium:YAG laser, including incision accuracy, perfect hemostasis and minimal tissue damage¹⁷. Thulium:YAG laser shows a rapid vaporization and coagulation ability of the prostate tissue at an energy output of 80W, whereas the laser ablation cutting is almost excellent starting with an energy output of 50W^{18,19}.

THE OBJECTIVE OF THE STUDY was to provide a comparative assessment of Thu-VEP vs. standard TURP in the treatment of benign prostatic hyperplasia.

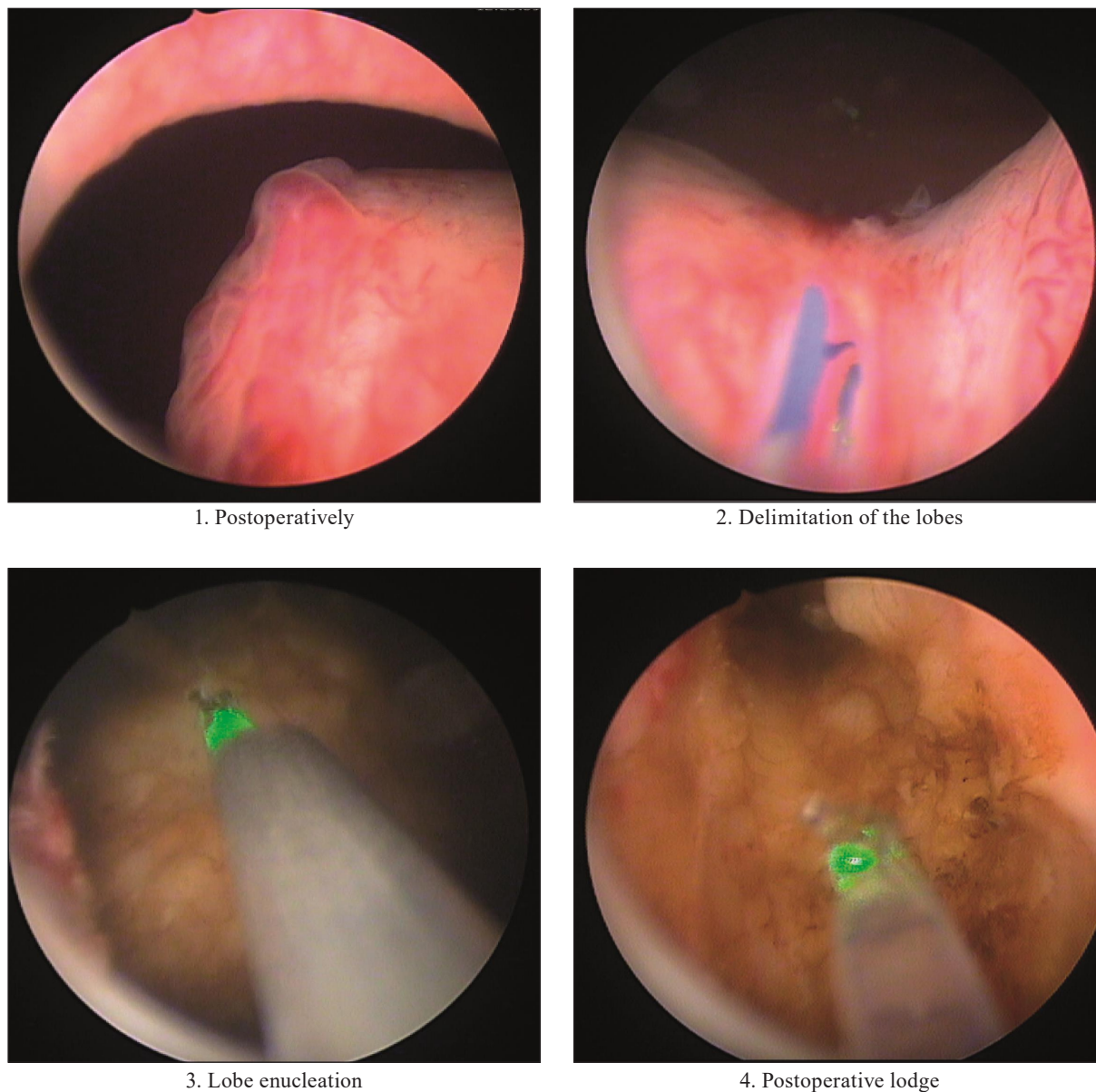


Figure 1. Thu-VEP – intraoperative images.

MATERIAL AND METHODS

The study was conducted on 81 patients with BPH, regarding an appropriate surgical treatment, including ThuVEP (40 patients) and TURP (41 patients), between May and December 2018. All patients were assessed before and at 3, 6 and 12 months after surgery, according to the International Prostate Symptom Score (IPSS), Quality of Life Score (QoL) and International Index of Erectile Function (IIEF-5), physical and digital rectal examination, prostate specific serum antigen (PSA) assessment, reno-vesical ultrasound with assessing post-void residual (PVR) urine volume, transrectal prostate ultrasound and prostate volume measurement, uroflowmetry and

Q-mean and Q-max assessment. The postoperative complications were recorded according to 2004 Clavien-Dindo classification. The inclusion criteria were as follows: age ≤ 80 years, residual urine volume (PVR) ≥ 70 mL, and Q-max ≤ 10 mL/s. The exclusion criteria were as follows: the neurogenic bladder, a confirmed prostate or bladder cancer, prior surgical history on the prostate or urethra, or presence of a long-term uterine catheter. All patients underwent surgery in the lithotomy position under spinal anesthesia. A Karl Storz 26Fr continuous flow resectoscope and saline irrigation was used to perform ThuVEP in all cases. The 80W settings of the Thulium:YAG laser (Revolix Duo, Lisa-Laser,

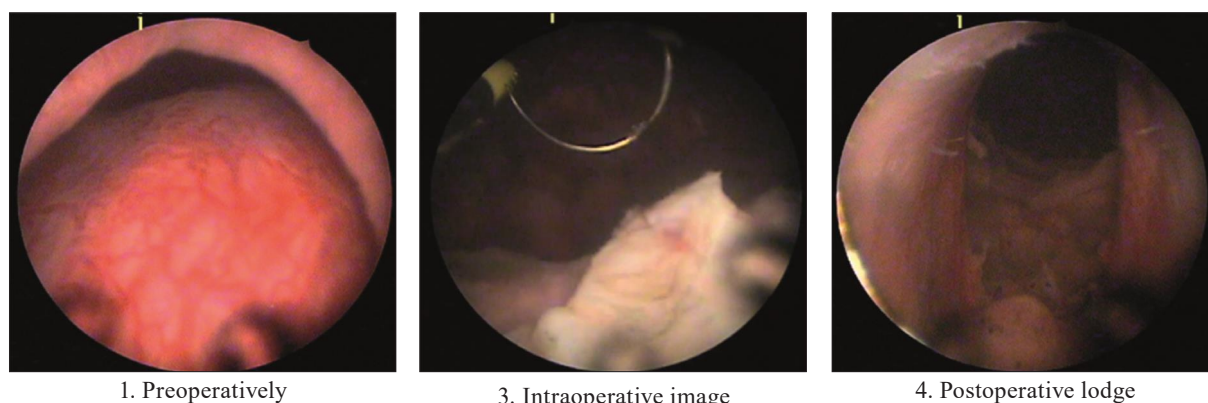


Figure 2. TURP – intraoperative images.

Table 1. Preoperative assessment (81 patients).

	Thu-VEP	TURP
Number of patients	40	41
Age, years	67±4	65±3
Q _{max} , ml/s	8.2±2.1	8.1±2.5
Q _{mean} , ml/s	7.3±1.9	7.1±1.6
Urine output, mL	131±23	124±27
IPSS	21±2	20±3
QoL	4±1	4±1
Prostate volume, mL	69±9	63±7
PVR, mL	92±19	87±22
PSA, ng/mL	3.3±2.1	3.5±1.7

Legend:

Thu-VEP - Thulium:YAG vapo-enucleation laser of the prostate; TURP- transurethral resection of the prostate; IPSS - International Prostate Symptom Score; QoL - Quality of life score; PSA - Prostate specific antigen; PVR - post-void residual urine volume; IIEF - International Index of Erectile Function 5; Q-mean - the mean urinary flow rate; Q-max - maximum flow rate

Germany) were used for tissue enucleation. The laser energy was provided through Rigi-Fib 550mc optical fiber with terminal emission. The evacuation of enucleated tissue was realized after monopolar fragmentation.

TURP was performed using a standard Karl Storz 26Fr continuous flow resectoscope, cutting power - 120W and coagulation power - 60W. Turusol was used as irrigation solution.

By the completion of both procedures, the bladder drainage was carried out via a triple lumen Foley 22Fr catheter. The removed tissue was submitted to histological examination. In case of pronounced hematuria, a continuous irrigation system was used

Table 2. Surgical data (81 patients)

	Thu-VEP	TURP
Operating time, min	64±19	45±12
Tissue removed volume, g	42±12	40±17
Blood loss, g/L	1,2	1,9
Catheterization time, days	2±1	2±1
Hospital length, days	5±1	5±1

Legend:

Thu-VEP - Thulium:YAG vapo-enucleation laser of the prostate; TURP- transurethral resection of the prostate

soon after surgery. Both groups of patients were administered one hour antibiotic therapy before and long-term medication after surgery depending on the urine culture. The following parameters were registered after surgery: the operating time, the removed tissue weight, low hemoglobin level, time of catheterization, hematuria and hospital stay length. All patients were monitored over 24 hours after the urinary catheter was removed within hospital settings.

RESULTS

Throughout the study, patients completed the follow-up questionnaires. During their visits, all the parameters provided in the study were assessed. By the completion of the follow-up period, the data analysis was carried out using the Student's t-test. There were no statistically significant differences between the study groups. Thus, the studied groups proved to be relatively homogeneous (Table 1).

The operative indices were registered and analyzed (Table 2). Both the removed tissue volume and duration of surgical intervention were higher in the ThuVEP group, being explained by the complete enucleation of the adenomatous tissue, which was subsequently subjected to fragmentation. However,

Table 3. Postoperative dynamics (81 patients)

	Before surgery	After Surgery		
		3 months	6 months	12 months
IPSS				
Thu-VEP	21±2	9±1	8±2	6±1
TURP	20±3	10±2	9±1	8±1
QoL				
Thu-VEP	4±1	3±1	3±1	2±1
TURP	4±1	3±1	3±1	3±1
PVR, ml				
Thu-VEP	92±19	30±11	20±6	15±11
TURP	87±22	32±9	23±10	22±7

Legend:

Thu-VEP - Thulium:YAG vapo-enucleation laser of the prostate; TURP- transurethral resection of the prostate; IPSS - International Prostate Symptom Score; QoL - Quality of life score; PVR - post-void residual urine volume

Table 4. Changes in urodynamic parameters (81 patients)

Treatment method	Before surgery		After surgery					
			3 months		6 months		12 months	
	Q-max (ml/s)	Urine output (mL)	Q-max (ml/s)	Urine output (mL)	Q-max (ml/s)	Urine output (mL)	Q-max (ml/s)	Urine output (mL)
Thu-VEP	8.2±2.1	131±23	17±1.2	185±7	18±0.9	204±10	20±1.1	209±7
TURP	8.1±2.5	124±27	17±0.5	176±4	18±1	201±6	18±1.5	204±8

Legend:

Thu-VEP - Thulium:YAG vapo-enucleation laser of the prostate; TURP- transurethral resection of the prostate; Q-mean - the mean urinary flow rate; Q-max - maximum flow rate

the most profuse blood loss was registered in the TURP group.

At 3 and 6 months of follow-up, no statistically significant differences were detected between the 2 groups regarding IPSS, QoL, Q-max and PVR. At one year follow-up, a more significant improvement of IPSS was found particularly in ThuVEP group (Table 3).

A significant improvement in QoL and Q-max was registered in both groups, showing better results in the ThuVEP group. The PVR volume decreased by 90% in the ThuVEP group and by 85% in the TURP group. The changes in urodynamic parameters recorded throughout the study are shown in Table 4.

During the preoperative period, 48% of patients in the ThuVEP group and 50% in the TURP group reported satisfactory erectile function according to the IIEF-5 questionnaires. The impaired erectile function was different in the postoperative period (Table 5). Thus, an almost similar reduced erectile function was reported in both groups at 3-month follow-up, which further improved at 12 months of surveillance, followed by an almost complete recovery in the ThuVEP group, the results being as those reported by Netsch²⁰. 19.5% of patients from the TURP group reported a significantly reduced erectile function.

In sexually active patients, the retrograde ejaculation was reported in 22 cases out of 40 (55%) from the ThuVEP group and in 26 cases out of 41 (63.4%) from the TURP group during the postoperative period. Retrograde ejaculation has been reported to become steady over time that has persisted in all patients who complained of this type of consequence throughout the surveillance period. During the follow-up period, a range of complications of different severity were detected, however these did not present life threat to the patients. No profuse bleeding was reported in the ThuVEP group. However, one patient from the TURP group required blood transfusion and 2 patients required a continuous irrigation system combined with hemostatic therapy due to a pronounced macrohematuria. Postoperatively, 4 patients (10%) in the ThuVEP group and 6 patients (14.6%) in the TURP group complained of transient urinary incontinence, which subsequently disappeared over 3 months of surveillance. Urinary tract infections were recorded in the early postoperative period in 2 patients (5%) in the ThuVEP group and in 3 patients (7.31%) in the TURP group. Antibacterial treatment was carried out according to the urine culture, which proved to be successful in all cases. During the 12-month follow-up, only one case of urethral

Table 5. Perioperative changes in erectile function (IIEF-5) (81 patients)

Treatment method	Before surgery	After surgery		
		3 months	6 months	12 months
Thu-VEP	12±2	9±1	10±1	12±1
TURP	13±2	9±2	10±2	11±1

Legend:

Thu-VEP - Thulium:YAG vapo-enucleation laser of the prostate; TURP- transurethral resection of the prostate

Table 6. Postoperative complications according to 2004 Clavien-Dindo classification (81 patients).

	Thu-VEP, No. of patients (%)	TURP, No. of patients (%)	Complication severity
Transient urinary incontinence	4 (10%)	6 (14.6%)	Grade I
Repeated catheterization	0	1 (2.4 %)	
Blood transfusion	0	1 (2.4 %)	Grade II
Urinary tract infections	2 (5%)	3 (7.3%)	Grade III
Urethral stricture	1 (2.5%)	2 (4.8%)	Grade III b
Bladder neck sclerosis	0	1 (2.4%)	
TURP syndrome	0	0	Grade IV
Total	7 (17.5%)	14 (33.9%)	

Legend:

Thu-VEP - Thulium:YAG vapo-enucleation laser of the prostate; TURP- transurethral resection of the prostate

stricture was registered in the ThuVEP group. At the same time, 2 patients with urethral strictures and one patient with cervical sclerosis were identified in the TURP group. These complications were surgically treated by performing a stricture incision, as well as by using laser fiber.

The catheterization time and postsurgical hospital length were similar in both groups. One case of acute urinary retention was recorded in the TURP group, which resolved over 48 hours after re-catheterization, followed by NSAID therapy.

DISCUSSION

Thulium: YAG laser is one of the most recently implemented laser energy sources used in endo-urological interventions. Due to the laser's better absorption coefficient of water from the tissues with which it comes into contact, it enables a precise and fast incision, followed by an efficient hemostasis. Thus, the laser beam that is applied directly on the tissue and being well absorbed might penetrate the tissues to only 0.2 mm deep^{8,21,22}. Superficial damage provides better viability of the underlying structures, as well as a good preservation of the morphological and functional components of the tissue. Once implemented, the ThuVEP technique has proved to be very efficient in the treatment of all BPH volumes. Thus, this procedure might be applied to all patients suffering from BPH, including the enlarged ones

(≥80 mL), who were previously treated by open surgical techniques. These data have been mentioned in a series of recent specialized publications. Thus, the study presented by Lin and Chang reported total complication rates of 20.7% vs 30% (ThuVEP vs TURP), which coincides with the data obtained in our study (17.5% - ThuVEP, and 33.9% - TURP), thus supporting the data reported in the pertinent literature²³. The low incidence rate of grade II, III and III b complications (blood transfusions, urinary tract infections, urethral strictures, and bladder neck sclerosis) assessed according to the Clavien-Dindo classification (2004) are similar to data retrieved from specialized literature and thus fully confirm the operational safety of ThuVEP^{1,24}. However, no grade IV severity complications, commonly reported in the classical endourological method - TURP (e.g. TURP syndrome), were found in our study. The obtained results suggest that ThuVEP might be recommended for all patients who require surgical treatment for BPH due to its higher safety compared to classical endourological procedures. Besides its operative safety, the surgical procedure is also more efficient.

The urodynamic indices, IPSS and QoL scores also showed improvement, being also sustained by data from related literature^{1,17}. Aside from its major advantages, the laser still exhibits high technical complexity due to the difficult and fine process of enucleation, followed by evacuation of adenomatous tissue²⁵. It is worth mentioning the need to stabilize

the procedure of evacuation of enucleated tissue. It can be regulated by urologists and is directly related to the technical capacity (morcellator availability), surgeon's preferences and mandatory experience. In this regard, there are two main procedures: I – nodule morcellation and II – fragmentation of devascularized and enucleated tissues via standard resection. Fragmentation via resection is a less popular technique due to a rather higher intra-operative time, however it shows operative advantages, as well (it excludes the risk of bladder perforation). Thus, although being a difficult procedure, fragmentation is a recommended surgical measure that requires mandatory additional training.

The main limitation of our study is related to the relatively low number of patients included.

CONCLUSIONS

ThuVEP is a procedure of major efficacy and highest efficiency in the treatment of BPH. Thulium:YAG laser used in the surgical treatment of BPH is considered superior compared to the classic TURP technique, as well as a promising one for clinical practice. The results obtained at one year of post-operative surveillance are quite encouraging, whereas the long-term patients' follow-up is needed for the quality assessment of the procedure.

Author Contributions:

Conceptualization, A.P. and V.G.; methodology, V.G.; software, A.P.; validation, A.P. and V.G.; formal analysis, A.P.; investigation, A.P.; resources, A.P.; data curation, A.P. and V.G.; writing—original draft preparation, A.P.; writing—review and editing, A.P, V.G.; visualization, A.P.; supervision, V.G.; project administration, A.P. All the authors have read and agreed with the final version of the article.

Compliance with Ethics Requirements:

"The authors declare no conflict of interest regarding this article"

"The authors declare that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008(5), as well as the national law. Informed consent was obtained from all the patients included in the study"

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