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Y.A. Nakonechnyi

Vesicourethral anastomosis modified posterior support in extraperitoneoscopic radical prostatectomy

SNPE «Danylo Halytskyi Lviv National Medical University», Ukraine

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Despite significant advances in surgical techniques for radical prostatectomy (RP), early urinary continence (UC) remains one of the clinical challenges. Multiple vesicourethral anastomosis (VUA) techniques, including anatomical reconstruction and suspension strategies, have been proposed to improve urinary continence outcomes. However, a clear consensus on the optimal approach has yet to be established.

Aim – to describe and evaluate the safety and feasibility of the modified posterior support of the vesicourethral anastomosis (PS-VUA) in the context of urinary continence (UC) after extraperitoneoscopic radical prostatectomy (ERP).

Materials and methods. This prospective study included 54 patients with non-metastatic prostate cancer (PCa) who underwent ERP. Patients were assigned into two equal groups (n=27 each) according to whether the PS-VUA was performed. Urinary continence (UC) was evaluated over a 12-month follow-up period after surgery.

Results. A statistically significant UC improvement was observed during the first 3 postoperative months in the group of patients who underwent PS-VUA ($p<0.05$). No statistically significant differences were observed between the study groups in terms of clinical characteristics, preservation volume, or postoperative complications (limited to Clavien–Dindo grade I–II events).

Conclusions. PS-VUA represents a safe and feasible surgical technique that may contribute to improved early UC outcomes following ERP in some groups of patients.

The study was conducted in accordance with the Declaration of Helsinki. The protocol was approved by the Local Ethics Committee. Written informed consent was obtained from all participants.

The author declares no conflict of interest.

Keywords: radical prostatectomy, vesicourethral anastomosis, posterior support, prostate cancer.

Модифікована задня підтримка везкоуретрального ананстомозу при екстраперитонеоскопічній радикальній простатектомії

Й.А. Наконечний

ДНТ «Львівський національний медичний університет імені Данила Галицького», Україна

Попри значний розвиток технік виконання радикальної простатектомії (RP), питання раннього утримання сечі (UC) зберегло свою актуальність. Протягом останніх років було запропоновано численні варіації виконання везикоуретрального анастомозу (VUA), а також різні методики анатомічної реконструкції та задньої підтримки з метою покращення функціональних результатів. Проте консенсус щодо оптимальної техніки виконання наразі відсутній.

Мета – описати та оцінити безпеку та доцільність виконання модифікованої задньої підтримки везикоуретрального анастомозу (PS-VUA) у контексті UC після екстраперитонеоскопічної радикальної простатектомії (ERP).

Матеріали та методи. Це проспективне дослідження охопило 54 пацієнти з неметастатичним раком передміхурової залози (PCa), яким виконано ERP. Пацієнтів розподілено на дві рівні групи по 27 осіб залежно від виконання PS-VUA. UC оцінювалося протягом 12 місяців після операції.

Результати. Статистично значуще покращення UC констатовано протягом перших трьох післяопераційних місяців у групі пацієнтів, яким виконували PS-VUA ($p<0.05$). Вірогідні відмінності між досліджуваними групами щодо клінічних характеристик, об'єму презервації або післяопераційних ускладнень (обмежених подіями за класифікацією Клавіє–Діно I–II ступеня) не виявлено.

Висновки. PS-VUA є безпечною технікою, яка може сприяти покращенню UC після ERP у певної групи пацієнтів.
Дослідження виконано відповідно до принципів Гельсінської декларації. Протокол схвалено місцевим етичним комітетом. Отримано інформовану згоду усіх учасників.
Автор заявляє про відсутність конфлікту інтересів.

Ключові слова: радикальна простатектомія, задня підтримка везикоуретрального анастомозу, рак простати.

Introduction

Radical prostatectomy is a standard curative treatment for localized prostate cancer (PCa); however, postoperative urinary incontinence remains a frequent and clinically relevant complication that adversely affects early quality of life [27]. Despite continuous refinement of surgical techniques, optimization of early urinary continence (UC) recovery remains an unresolved challenge [4]. Various surgical strategies, including meticulous dissection, preservation of periurethral support structures, and reconstructive techniques, have been proposed to improve functional outcomes [9,27]. Support and suspension of the vesicourethral anastomosis (VUA) restore bladder neck stability and vesicourethral alignment, potentially accelerating continence recovery [3,22,24,28]. However, no consensus exists on the optimal dissection or reconstruction technique [7,13,25].

The aim of the study is to describe and evaluate the safety and feasibility of the modified posterior support (PS) of the vesicourethral anastomosis (PS-VUA) in the context of UC after extraperitoneoscopic radical prostatectomy (ERP).

Material and methods of the study

This prospective study included 54 patients with non-metastatic PCa who underwent ERP between 2022 and 2024 at the University Clinic of Danylo Halytskyi Lviv National Medical University. Preservation of the posterior wall of the bladder-neck outlet (PW-BNO-P), arcus tendineus (AT-P), puboprostatic ligaments (PPL-P), distal portion of the dorsal vascular complex (DP-DVC-P), and maximal functional urethral length (MFUL-P) was performed in all cases. PS-VUA was performed in 27 patients (PS-1), and outcomes were compared with those in the group where this modification was not applied (PS-0). Exclusion criteria consisted of metastatic PCa, finasteride use, and neoadjuvant or adjuvant androgen-deprivation therapy. UC outcomes were evaluated at 1, 3, 6, 9, and 12 months after the surgery. UC was considered present if the patient had a voided volume ≥250 ml and no leakage during a cough stress test, which was confirmed by objective examination results using ultrasound and uroflowmetry. According to these criteria, UC was preserved in all patients prior to surgery.

Surgical technique

All ERP procedures were performed according to the principles of personalized preservation and precise MRI-based surgical planning, as previously described [17,18]. The VUA with single-layer anatomical reconstruction (SLAR) and anterior smooth muscle urethral sphincter preservation (AUS-P) was done in all cases, following the previously published technique [16]. Once the knots at the 7 and 5 o'clock positions were tied, the long suture ends were intentionally preserved to enable PS (Fig. 1).

The last one was achieved by tying together the knots ends of the sutures placed at the 7 and 9:30 o'clock positions on the left side, and at the 5 and 2:30 o'clock positions on the right side, at the PPL-P surface (Fig. 2, 3).

This maneuver resulted in a more cephalad positioning of the posterior aspect of the VUA, providing enhanced posterior support and promoting anatomically favorable alignment (Fig. 4).

VUA watertightness was then assessed; if leakage was detected, additional superficial sutures were applied.

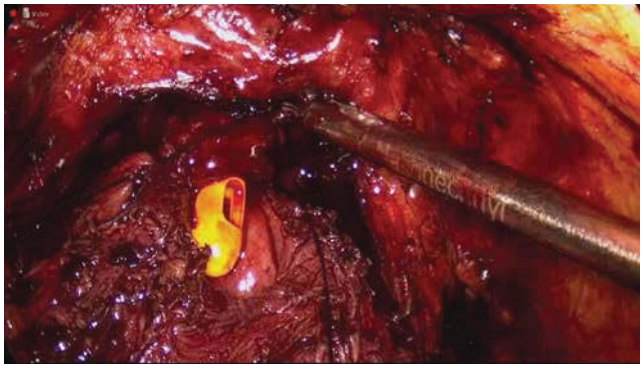

Fig. 1. Tying of vesicourethral anastomosis sutures placed at the 5 and 7 o'clock positions on the surface of the Denonvilliers' fascia

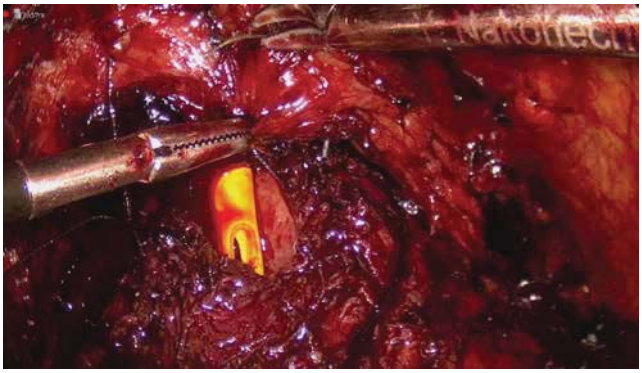

Fig. 2. Vesicourethral anastomosis sutures placed at the 2:30 and 9:30 o'clock positions, incorporating the PPL-P

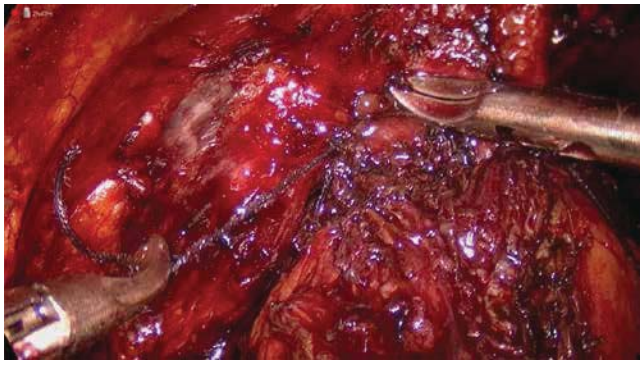

Fig. 3. Performance of vesicourethral anastomosis posterior suspension on the left side

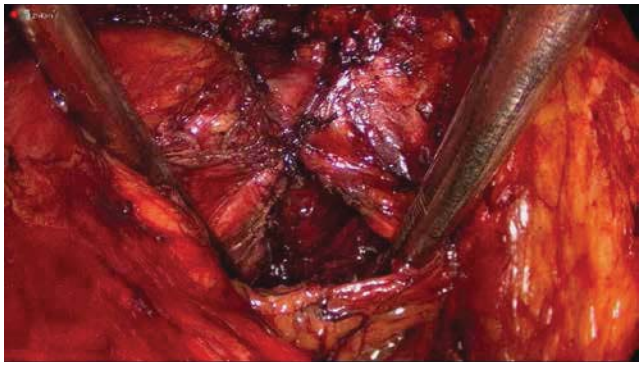

Fig. 4. Final appearance of the completed VUA shown from the right side, with the arcus tendineus led out laterally

Statistical analysis was performed using MedCalc free statistical calculators and STATISTICA version 10 (64-bit). Numerical data are presented as median (Me), lower quartile (LQ), and upper quartile (UQ). The Mann–Whitney U test was used to compare quantitative variables between independent groups. Results were considered statistically significant at $p \leq 0.05$.

The study was conducted in accordance with the principles of the Declaration of Helsinki. The study protocol was approved by the Local Ethics Committee, and written informed consent was obtained from all participants.

Results of the study

A total of 54 patients with clinically localized PCa were included in the analysis and stratified into two equal groups according to posterior suspension status: PS-0 (n=27) and PS-1 (n=27). The median age of the entire cohort was 66 years (63; 72), and the median body mass index (BMI) was 30.0 kg/m^2 (27.4; 35.6), indicating a predominance of overweight and obese patients. Multiparametric magnetic resonance imaging (mpMRI), clinical T stage, and preoperative prostate-specific antigen (PSA) assessment demonstrated a high burden of clinically significant disease, with a median PI-RADS score of 4 (4; 5), a median clinical stage of cT2c (cT2a; cT2c), and a median PSA level of 11.5 ng/mL (9.0; 19.6), respectively. Benign prostatic hyperplasia (BPH) was prevalent in the cohort, with a median prostate volume (PV) of 52.5 mL (45.0; 63.8). Baseline demographic and oncological characteristics were well balanced between the PS-0 and PS-1 groups. No statistically significant differences were observed between the groups with respect to age (p=0.199), BMI (p=0.856), PSA level (p=0.156), prostate volume (p=0.586), PI-RADS score (p=0.602), or clinical T stage (p=0.784), as assessed using the Mann-Whitney U test (Table 1).

Postoperative pathological assessment confirmed organ-confined or locally advanced disease in the majority of cases, with a median pathological T stage of pT2c (pT2c; pT3b). No significant differences in pathological T stage distribution were identified between the PS-0 and PS-1 groups (p=0.847). Tumor grading demonstrated a median preoperative ISUP grade group of 2 (2; 3), which increased to a median pathological ISUP grade group of 3 (2; 4) after definitive histopathological evaluation. Both preoperative and pathological ISUP grade distributions were comparable between groups (p=0.191 and p=0.835, respectively).

Perioperative parameters were similar between the two study groups. The median operative time was 144.5 minutes (130; 155), with no significant difference between PS-0 and PS-1 (p=0.511). The median VUA time was 20.7 minutes (18.9; 23.1), also without significant intergroup variation (p=0.121). Median estimated blood loss was 335 mL (275; 415) and did not differ significantly between groups (p=0.478). Postoperative recovery was comparable in both groups. The median length of hospital stay was 8 days (7; 9), and urethral catheter removal (UC-R) was typically performed on postoperative day 7 (7; 8), with no statistically significant differences observed (p=0.729 and p=0.124, respectively).

Complications among the study participants were limited to Clavien-Dindo grade I-II events, occurring in 14.8% of patients (n=8). Intraoperative vesicourethral anastomosis leakage (IOVUAL) occurred in 9.3% of patients (5/54), including 11.1% (3/27) in the PS-0 group and 7.4% (2/27) in the PS-1 group (p=0.654). Postoperative vesicourethral anastomosis leakage (POVUAL) was observed in 7.4% of cases overall (4/54), with rates of 11.1% (3/27) in PS-0 and 3.7% (1/27) in PS-1, without statistical significance (p=0.312). Anastomotic leakage events did not influence hospital stay duration or timing of UC-R.

No cases of urethral stricture were recorded during the follow-up period. The extent of nerve-sparing (NS) preservation did not differ significantly between groups (Table 2).

Table 1
Study groups clinical data, Me (Q1; Q3)

Parametr	PCa (n=54)	PS-0 (n=27)	PS-1 (n=27)	p-value (PS-0 vs PS1)
Age, years	66 (63; 72)	65 (62; 71)	68 (63; 73)	0.199
BMI	30 (27.4; 35.6)	30.8 (25.7; 37.7)	30 (27,5; 34.3)	0.856
PSA, ng/ml	11.5 (9; 19.6)	12.4 (9.3; 19.7)	10.7 (7.98; 17.2)	0.156
PV	52.4 (45; 63.8)	53 (44.5; 69.8)	52.2 (45.4; 57.7)	0.586
PIRADS	4 (4; 5)	4 (4; 5)	4 (4; 5)	0.602
T-stage	2c (2a; 2c)	2c (2b; 2c)	2c (2a; 2c)	0.784
pT-stage	2c (2c; 3b)	2c (2c; 3b)	2c (2c; 3b)	0.847
ISUP	2 (2; 3)	2 (2; 2)	2 (2; 3)	0.191
pISUP	3 (2; 4)	3 (2; 4)	3 (2; 3)	0.835
OT, min	144.5 (130; 155)	145 (134; 160)	144 (121; 155)	0.511
VUAT, min	20.7 (18.9; 23.1)	19.7 (18.6; 23.6)	21.7 (19.2; 23.1)	0.121
EBL, ml	335 (275; 415)	335 (280; 415)	325 (270; 425)	0.478
HS, days	8 (7; 9)	8 (7; 9)	8 (7; 9)	0.729
UC-R, day	7 (7; 8)	7 (7, 9)	7 (7; 8)	0.124
IOVUAL	9.3% (5)	11.1% (3)	7.4% (2)	0.654
POVUAL	7.4% (4)	11.1% (3)	3.7% (1)	0.312

Notes: PS – posterior support, PS-0 – not performed, PS-1 – performed; BMI – body mass index; PSA – prostate-specific antigen; PV – prostate volume; PIRADS – Prostate Imaging-Reporting and Data System; ISUP – International Society of Urological Pathology grade; OT – operative time; VUAT – vesicourethral anastomosis time; EBL – estimated blood loss; HS – hospital stay; UC-R – urinary catheter removal; IOVUAL – intraoperative vesicourethral anastomosis leakage; POVUAL – postoperative vesicourethral anastomosis leakage.

Table 2
Study groups preservation volume data, % (n)

Parametr	PCa (n=54)	PS-0 (n=27)	PS-1 (n=27)	p-value (PS-0 vs PS1)
NS-none	1.9 (1)	0 (0)	3.7 (1)	0.336
NS-partial-none	22.2 (12)	18.5 (5)	25.9 (7)	0.524
NS-partial	18.5 (10)	22.2 (6)	14.8 (4)	0.496
NS-partial-full	46.3 (25)	48.1 (13)	44.4 (12)	0.795
NS-full	11.1 (6)	11.1 (3)	11.1 (3)	0.987

Notes: NS – nerve-sparing; PCa – prostate cancer; PS – posterior support, PS-0 – not performed, PS-1 – performed.

The most common pattern was partial-full NS, observed in 46.3% of the total cohort, with comparable rates in PS-0 (48.1%) and PS-1 (44.4%) (p=0.795). Complete NS was achieved in 11.1% of patients in both groups (p=0.987). Full bladder neck preservation was performed whenever possible, taking into account intravesical prostate protrusion and oncological safety. The latter was achieved in 15 patients (27.8%), with no significant difference between the study groups: 8 patients in the PS-0 group and 7 patients in the PS-1 group. UC improved progressively over time in the entire cohort (Table 3, Figure 5). Overall continence rates were 48.1% at 1 month, 64.8% at 3 months, 74.1% at 6 months, 85.2% at 9 months, and 94.4% at 12 months postoperatively. Patients in the PS-1 group demonstrated significantly higher early continence rates compared with those in the PS-0 group. At 1 month, continence was achieved in 62.9% of PS-1 patients versus 33.3% in PS-0 (p=0.032). This difference remained significant at 3 months (77.8% vs 51.9%, p=0.049). At later follow-up intervals (6, 9, and 12 months), continence rates continued to favor the PS-1 group numerically; however, these differences did not reach statistical significance (p=0.223, p=0.456, and p=0.571, respectively).

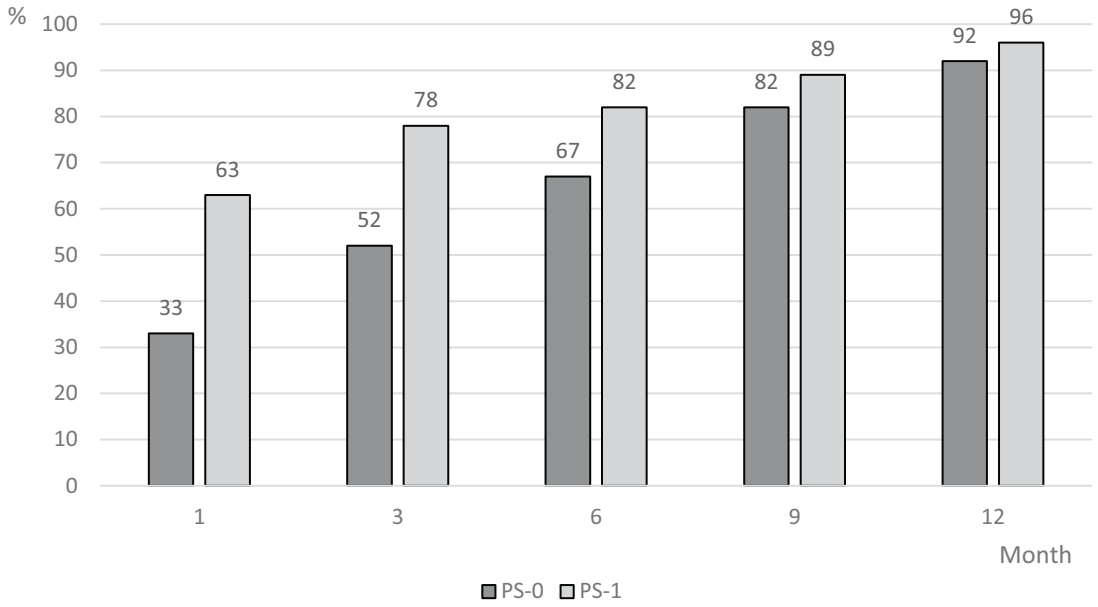

Fig. 5. Post-intervention urinary continance outcomes in study groups

Discusssion

Postoperative UC remains an important functional outcome following radical prostatectomy and continues to drive refinements in the understanding of surgical anatomy, dissection strategies, and reconstructive techniques [7]. Despite substantial advances, early UC recovery remains variable, reflecting the complex interplay between sphincteric integrity, periurethral support, and vesicourethral alignment, particularly across different patient subgroups [4]. UC depends on preservation of the bladder neck, MFUL, levator ani muscles, and pubovesical complex, along with the surrounding paraprostatic neurovascular and fascial structures that together form a functional continuum [9,27]. Contemporary studies have shifted the paradigm from viewing UC as the function of an isolated sphincter to recognizing it as the result of an integrated vesicourethral support system [5]. Disruption of the aforementioned structures during surgery may increase urethral mobility and delay functional recovery [22]. Within this framework, successive axial celloidin-embedded sections have provided detailed insight into the morphology and spatial relationships of the circular, longitudinal, and trigonal muscle components at the bladder outlet, demonstrating that ring-like and sling-like structures formed by the circular muscle of the bladder neck play a pivotal role in maintaining proximal urethral stability and closure pressure [12]. Collectively, these anatomical observations provide a mechanistic rationale for extended anatomical preservation, as well as reconstructive and suspension techniques during radical prostatectomy, aimed at re-establishing physiological vesicourethral alignment and support, thereby facilitating early recovery of UC. [6,9,27]. Numerous reconstructive strategies have been proposed to address this anatomical disruption [1,3,8-11,14,19,22-25,28]. Recent approaches demonstrate improved UC outcomes when total anatomical reconstruction (TAR) is applied [8,19,22].

These findings are supported by meta-analyses, which indicate that total or near-total pelvic floor reconstruction significantly improves short-term continence, with diminishing differences observed during long-term follow-up [26]. Nevertheless, selected techniques have shown sustained benefits. S. Leslie et al. (2023) reported optimization of UC over a 12-month follow-up following application of a bladder neck fascial sling [11]. Suspension sutures have increasingly been conceptualized not as tension-bearing constructs, but rather as positional stabilizers of the vesicourethral junction. Tokas and Nägele emphasized that the efficacy of suspension depends primarily on the direction and vector of lift, favoring anatomical repositioning that restores physiological geometry rather than excessive traction [23]. N.E. Canvasser et al. demonstrated improved early UC following posterior urethral suspension, supporting its role as a continence-facilitating adjunct [3]. These findings are consistent with outcomes reported for male sling procedures used to treat post-prostatectomy stress urinary incontinence, which further underscore the biomechanical importance of posterior urethral support [15,21]. Clinical results from both adjustable and fixed sling systems indicate that restoration of urethral position and angle, rather than increased outlet resistance, is critical for continence recovery [2,20]. In further research, H.D. Kominsky et al. highlighted the importance of posterior support as a shared mechanism for conti-

nence, reporting similar early UC outcomes between Retzius-sparing prostatectomy and posterior urethral suspension, suggesting convergence toward a common biomechanical endpoint [10]. Studies by M.L. Zanoni et al. (2020) and M. Valerio et al. (2023) demonstrated that comprehensive restoration of periurethral anatomy, combined with additional support, resulted in improved early UC outcomes [24,28]. These principles are consistent with the modified PS-VUA technique evaluated in the present study. Despite these encouraging data, K. Atchia et al. reported no significant improvement in early continence following iliopectineal ligament suspension in a randomized controlled trial, highlighting the need for future studies to explore alternative variations of suspensory sutures or reconstruction techniques that may provide more effective posterior urethral support and facilitate earlier recovery of continence [1]. The discrepancies in UC outcomes likely reflect heterogeneity in patients' baseline characteristics, the extent of paraprostatic preservation, suspension techniques, fixation points, and concomitant reconstructions. This study has several limitations, including the relatively small sample size, non-randomized design, single-surgeon experience, and baseline characteristics such as age, PV, and BMI. These factors likely contribute to delayed UC recovery after radical prostatectomy through impaired tissue healing, increased pelvic floor load, and altered urethral angulation [4,7,9,27]. This highlights the potential role of reconstructive and suspension techniques in selected patients to support early functional recovery [1,10,14,24,28]. However, the true impact of additional VUA support remains uncertain, and further studies are needed to clarify its functional benefits and refine patient selection criteria.

Conclusions

PS-VUA represents a safe and feasible surgical technique that may contribute to improved early UC outcomes following ERP in some groups of patients. Larger cohorts are warranted to validate these findings and to establish potential functional advantages for specific groups of patients.

No conflict of interests was declared by the authors.

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Відомості про автора:

Наконечний Йосиф Андрійович *– PhD, доц. каф. урології ФПДО, ДНП «Львівський національний медичний університет імені Данила Галицького». Адреса: м. Львів, вул. Пекарська, 69; тел.: +38 (032) 275-76-32. https://orcid.org/0000-0002-6872-1889*

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