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Outcomes of transvaginal natural orifice transluminal endoscopic hysterectomy: a multi-centre retrospective study from Turkey (TR-MIGS)

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Kemal Gungorduk[a], Yasam Kemal Akpak[b], Selcuk Erkılınc[c], Koray Gorkem Sacinti[d], Vakkas Korkmaz[e], Serhan Can Iscan[f], Ahkam Goksel Kanmaz[g], Ghanim Khatib[h], Bahadır Kosan[i], Candost Hanedan[e], Emrah Toz[g], Varol Gülseren[j], Salih Taskın[k], Kemal Ozerkan[i] and Cagatay Taskıran[l]

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ABSTRACT

Background: Vaginal natural orifice transluminal endoscopic surgery (vNOTES) hysterectomy is gaining increasing popularity among gynaecological surgeons worldwide due to its minimally invasive nature and associated benefits. However, despite its growing adoption, it remains a relatively novel surgical technique that continues to be evaluated and refined in clinical practice. The primary objective of this study is to share and analyse our initial experiences with the implementation of vNOTES hysterectomy across six specialised gynaecological centres in Turkey.

Methods: This retrospective analysis included all women who underwent vNOTES hysterectomy, with or without salpingo-oophorectomy, for benign or malignant conditions. All procedures adhered to the standardised protocol described by Baekelandt *et al.* Data on baseline patient characteristics, intraoperative details, and postoperative outcomes were collected and analysed.

Results: A total of 685 patients underwent vNOTES procedures. Among them, 64 women (9.3%) had a history of one caesarean delivery, 38 (5.5%) had two prior caesareans, and 11 (1.6%) had three or more. Myoma, with or without accompanying metrorrhagia, was the most common surgical indication (53.0%). The mean operative time was 72.4 ± 40.2 min, and the average haemoglobin decrease was 1.3 ± 1.0 g/dL. The mean uterine weight was 204 ± 145 g. Intraoperative complications occurred in 1.7% of cases (n = 12), while postoperative complications were observed in 1.4% (n = 10). Conversion to conventional laparoscopy occurred in six cases (0.9%), primarily due to an obliterated pouch of Douglas or intraoperative complications. The average hospital stay was 2.3 ± 1.4 days.

Conclusions: These findings support vNOTES as a safe and effective surgical approach, offering a viable alternative to traditional laparoscopic or vaginal techniques in select patient populations.

PLAIN LANGUAGE SUMMARY

Transvaginal natural orifice transluminal endoscopic surgery (vNOTES) combines traditional vaginal surgical techniques with advanced single-port laparoscopy to treat various gynaecological conditions. Compared to conventional multiport laparoscopic surgery, vNOTES offers several key advantages, including reduced postoperative pain,

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Natural orifice transluminal endoscopic surgery; hysterectomy; minimally invasive surgery

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TR-MIGS: Turkish Platform of Minimally Invasive Gynecologic Surgery.

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faster recovery, shorter operative times, and improved cosmetic outcomes due to the absence of abdominal incisions. In a retrospective study conducted across six gynaecological centres, we evaluated the clinical outcomes of 685 hysterectomy procedures performed using vNOTES. We assessed operative time, postoperative pain scores, hospital stay duration, and complication rates. This multicentre study provides robust evidence supporting the efficacy and safety of vNOTES for hysterectomies performed for a wide range of uterine pathologies.

Introduction

Hysterectomy remains a complex and pivotal subject of investigation for surgical teams and represents a significant decision for women, often accompanied by sexual and psychological repercussions that may increase the risk of post-traumatic stress. Therefore, it is essential that individuals considering this procedure are thoroughly informed about the available surgical techniques, including vaginal, abdominal, and laparoscopic approaches (Giannini *et al.* 2022).

Vaginal hysterectomy (VH) is regarded as the preferred minimally invasive method for hysterectomy, offering shorter operative times and reduced hospital stays compared to laparoscopic hysterectomy. However, the prevalence of VH has declined markedly over the past decade. This trend may be attributed to several factors, including the increasing adoption of laparoscopic and robotic-assisted hysterectomies driven by technological advancements (ACOG Educational Bulletin 2017). These newer approaches offer enhanced intraoperative visualisation and faster recovery, and are often favoured by surgeons. The decline in surgical training focused on VH and the increasing complexity and comorbidities of patients, which may limit the feasibility of VH, have also contributed to this decrease (Einarsson *et al.* 2010, Luchristt *et al.* 2021).

Natural orifice transluminal endoscopic surgery (NOTES) represents an innovative advancement in minimally invasive surgery (Li and Hua 2020). Among its variants, transvaginal NOTES (vNOTES), which combines endoscopic and vaginal surgical techniques, has gained increasing acceptance in gynaecologic practice over the past decade (Li and Hua 2020, Baekelandt and Kapurubandara 2021).

Compared to VH, vNOTES offers greater versatility, particularly in cases where VH may be challenging such as in patients with non-prolapsed uteri, larger uteri, or mild adhesions. It is effective in treating benign conditions as well as certain early-stage gynaecologic malignancies, and is suitable for patients requiring concurrent procedures such as salpingectomy or adnexectomy (Huber and Hurni 2022, Baekelandt *et al.* 2024). Furthermore, vNOTES is well-suited for patients with large uteri, no previous deliveries, or multiple previous caesarean sections, demonstrating its adaptability (Li and Hua 2020, Baekelandt and Kapurubandara 2021). Unlike laparoscopic hysterectomy, vNOTES does not require an abdominal incision, offering superior cosmetic outcomes and reducing the risk of incisional complications including wound infections and hernias (Housmans *et al.* 2020). It also offers additional benefits such as shorter operative time, quicker hospital discharge, and reduced estimated blood loss (Housmans *et al.* 2020).

Although vNOTES hysterectomy is gaining popularity among gynaecologic surgeons, it remains a relatively novel technique. The objective of this study is to present our initial experience with the implementation of vNOTES across six gynaecologic centres in Turkey, with a focus on evaluating its feasibility, perioperative outcomes, and safety.

Methods

This multicentre retrospective analysis included patients who underwent vNOTES hysterectomy, with or without salpingo-oophorectomy, for benign or malignant conditions at six different institutions between January 2023 and May 2025 (Figure 1). Exclusion criteria were uterine prolapse greater than grade I according to the Pelvic Organ Prolapse Quantification system, a history of endometriosis or pelvic inflammatory disease, severe renal failure, severe cardiopulmonary disease, previous colorectal surgery, and contraindications to either general anaesthesia or the Trendelenburg position.

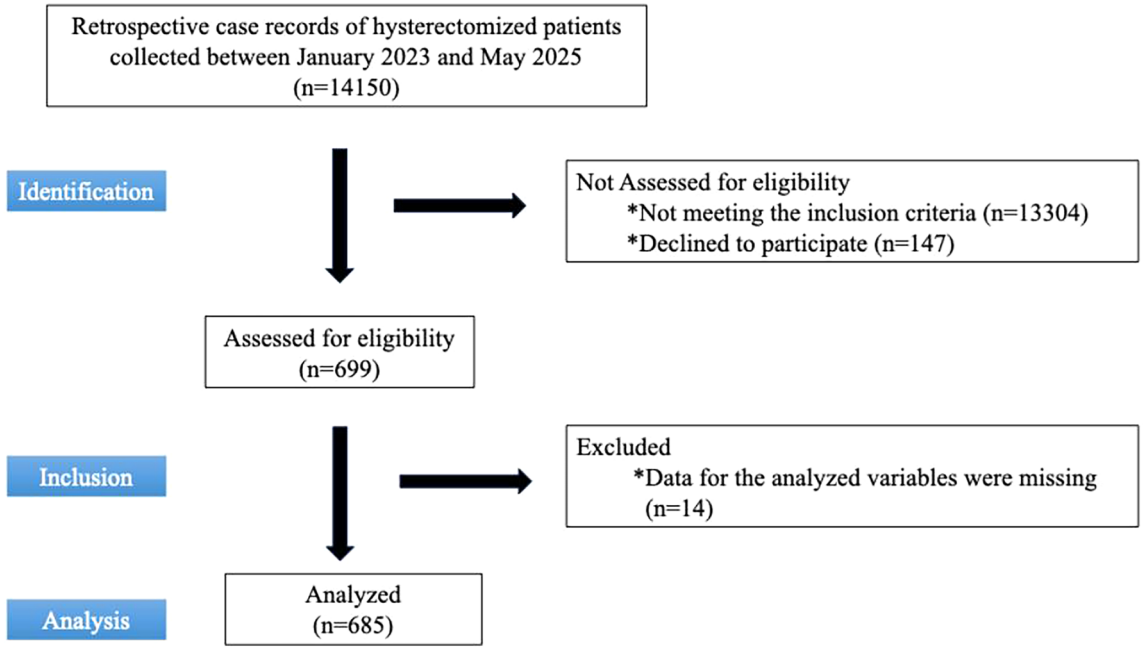


Figure 1. Flowchart of the study design.

Perioperative data were retrospectively collected from hospital electronic medical records and patient charts. Collected variables included patient age, body mass index (BMI, kg/m^2), number of vaginal deliveries and caesarean sections, history of previous pelvic or abdominal surgeries, indication for surgery, type of procedure performed, total operative time (measured from the vaginal incision to closure of the vaginal cuff), and surgical pathology findings (with an enlarged uterus defined as one weighing ≥ 280 g on pathological examination). Additional variables included intraoperative and postoperative complications, estimated blood loss, serum haemoglobin decrease (calculated as the difference between preoperative and 24-h postoperative haemoglobin levels), postoperative pain assessed using a visual analogue scale (VAS) at 6 and 24 h, and the length of postoperative hospital stay. All postoperative complications, including surgical failure, pelvic visceral injury, blood transfusion, vaginal vault bleeding or infection, urinary tract infection, and postoperative fever, were documented using Clavien Dindo classification (Dindo *et al.* 2004). Follow-up assessments were conducted at 1 and 4 weeks after the procedure.

All surgeries were performed by experienced gynaecologic surgeons following standardised protocols, with approximately 10 cases required to overcome the learning curve for each surgeon. The vNOTES hysterectomy was conducted in accordance with the standardised technique described by Baekelandt *et al.* (2019). Briefly, under general anaesthesia and with the patient in a 15° Trendelenburg position, a tenaculum was used to grasp the anterior cervical lip, and a circumferential cervical incision was made using an 11-mm scalpel and/or electrocautery. The cervical fascia was dissected using both blunt and sharp methods, followed by the creation of anterior and posterior colpotomies. A vNOTES surgical device was then inserted into the vaginal canal, and pneumoperitoneum was established with CO_2 insufflation (8–12 mmHg) to facilitate visualisation using a 10-mm 0° or 30° telescope. Standard laparoscopic instruments, including graspers, scissors, bipolar forceps, a suction-irrigation device, and a vessel-sealing instrument, were used to perform sequential high ligation and dissection of the uterosacral ligaments, uterine arteries, and adnexa from a caudal-to-cranial direction. The uterus and adnexa were removed transvaginally, and the vaginal cuff was closed using 1–0 Vicryl sutures. In cases requiring sentinel lymph node biopsy, retroperitoneal access was achieved via bilateral incisions in the lateral vaginal fornix prior to the hysterectomy.

Preoperative and intraoperative care adhered to the Enhanced Recovery After Surgery protocol for gynaecologic procedures, following international standards and guidelines (Scheib *et al.* 2019). The study adhered to the ethical principles outlined in the 1964 Declaration of Helsinki and received approval from

the local ethics committee (E-32623740-200-2500064205: 2025/58). Written informed consent was obtained from all participants prior to inclusion.

Data were analysed using MedCalc software (version 14.0; Mariakerke, Belgium). Categorical variables were presented as percentages and compared using the chi-square test, while continuous variables were expressed as means ± standard deviation and analysed using independent *t*-tests. A *p*-value of $< .05$ was considered statistically significant.

Results

During the study period, a total of 685 patients underwent vNOTES hysterectomy. Among them, 64 patients (9.3%) had a history of one caesarean section, 38 patients (5.5%) had undergone two caesarean deliveries, and 11 patients (1.6%) had experienced three or more caesarean sections. Additionally, 148 patients (21.6%) had a history of previous abdominal surgeries, such as cholecystectomy, appendectomy, or oophorectomy. Notably, 37.8% of the patients had a BMI > 30 kg/m^2 (Table 1).

The primary surgical indications were uterine myomas with or without metrorrhagia (53.0%), high-grade squamous intraepithelial lesion or cervical carcinoma *in situ* (1.0%), endometrial hyperplasia or carcinoma (19.0%), adnexal masses (8.9%), and other conditions (18.1%). A sentinel lymph node procedure was performed in 52 patients (7.6%) who were clinically evaluated for early-stage endometrial adenocarcinoma.

The mean operative time was 72.4 ± 40.2 min, and the average haemoglobin decrease was 1.4 ± 0.1 g/dL. The mean uterine weight was 204 ± 145 g, with 103 patients (15.0%) having a uterus weighing ≥ 280 g.

Intraoperative complications were observed in 12 patients (1.7%), while postoperative complications occurred in 10 patients (1.4%). Conversion to laparoscopy and completion was successfully achieved in six cases (0.9%). The reasons for conversion included unexpected endometriosis resulting in sidewall obliteration and adhesions involving the adnexa and sigmoid colon (two cases), extensive bowel adhesions to the adnexa and vascular pedicle in a patient with a previous laparotomy for a borderline ovarian tumour (one case), and the requirement for paraaortic lymphadenectomy following sentinel lymph node

Table 1. Preoperative patient demographics.

Variable	*N* = 685
Age[a] (years)	50.7 ± 9.3
Body mass index[a] (kg/m^2)	29.0 ± 5.5
Body mass index[b] ≥ 30 kg/m^2	37.8
Gravida[a]	3.4 ± 1.7
Parity[a]	2.5 ± 1.4
No previous vaginal delivery[a]	109 (25.9)
Caesarean section[b]	
1	64 (9.3)
2	38 (5.5)
≥3	11 (1.6)
Previous abdominal surgery[b]	
Appendectomy	53 (7.7)
Cholecystectomy	49 (7.2)
Adnexal surgery	31 (4.6)
Myomectomy	6 (0.9)
Other gastrointestinal surgery	4 (0.6)
Smoking history[b]	35 (5.1)
Alcohol consumption[b]	10 (1.5)
Diabetes[b]	43 (6.3)
Hypertension[b]	64 (9.3)
Coexisting diseases[b]	61 (8.9)
Indication for surgery[b]	
Myoma Uteri	169 (24.7)
Abnormal uterine bleeding	194 (28.3)
Cervical dysplasia/AIS	7 (1.0)
Adnexal mass	61 (8.9)
Endometrial hyperplasia and cancer	130 (19.0)
Other	124 (18.1)

[a]Mean ± SD.
[b]*n* (%).

Table 2. Surgical variables.

Variable	*N* = 685
Surgical procedure[a]	
Hysterectomy + unilateral/bilateral salpingectomy	300 (43.8%)
Hysterectomy + unilateral/bilateral salpingo-oophorectomy	333 (48.6%)
Hysterectomy + unilateral/bilateral salpingo-oophorectomy + SLNB	52 (7.6%)
Operation time[a]	72.4 ± 40.2
Intraabdominal pressure[a]	11.2 ± 1.3
Preoperative haemoglobin[a]	12.5 ± 1.5
Postoperative haemoglobin[a]	11.1 ± 1.4
Visual analogue scale of pain[a]	
6 h after surgery	4.0 ± 1.2
24 h after surgery	2.7 ± 0.8
Uterine weight[a]	204 ± 145
Uterine weight[b] ≥ 280 g	103 (15)
Intraoperative complications[b]	
Bladder injury	5 (0.7)
Ureter injury	1 (0.1)
Rectal serosal tear	5 (0.7)
Rectal injury	1 (0.1)
Other	–
Need for laparoscopy[b]	6 (0.9)
Need for laparotomy[b]	1 (0.1)
Postoperative complications (PC)[b]	
Haematoma	5 (0.7)
Vaginal cuff infection	2 (0.3)
Ilues	1 (0.1)
Clavien Dindo Clasification of PC	
Grade 1–2	4 (0.6)
Grade 3	3 (0.5)
Re-admission due to complications	6 (0.8)
Length of hospital stay[a] (days)	2.3 ± 1.4

[a]Mean ± SD.
[b]*n* (%).
SLNB: sentinel lymph node biopsy.

mapping (one case). One conversion was necessitated by a bladder injury during the anterior colpotomy, while another required conversion to laparotomy due to a 3-cm sigmoid colon injury.

All patients reported minimal postoperative pain, with a mean VAS score of 2.7 ± 0.8 at 24 h. The mean duration of hospital stay was 2.3 ± 1.4 days. Postoperative follow-up was conducted at the first and fourth weeks after surgery. Postoperative complications were documented in 10 patients, with vaginal cuff haematoma and infection being the most frequently observed. No major vascular injuries were reported in any patient. Six patients required re-admission: four due to unexplained pain and two for vaginal bleeding (Table 2).

Discussion

To the best of our knowledge, this is the first documented instance of gynaecological centres in Turkey utilising vNOTES hysterectomy and represents one of the largest case series reported in the literature. This study retrospectively analysed the outcomes of hysterectomies performed using the vNOTES technique in a cohort of 685 patients with uterine conditions across six specialised centres.

With the expanding application of vNOTES in gynaecologic surgery, its advantages, particularly the optimal access provided by this approach, have garnered increasing attention among surgeons worldwide, and several reports have been published in recent years (Bekkers *et al.* 2024, Interdonato *et al.* 2022, Kim *et al.* 2020, ACOG Educational Bulletin 2017). Although vNOTES has been shown to yield outcomes comparable to those of laparoscopic surgery, ongoing discussions continue globally regarding its precise indications and potential advantages over conventional techniques. According to a recent systematic review, vNOTES hysterectomy demonstrated equivalent surgical outcomes to laparoscopic hysterectomy while also offering benefits such as shorter operative times, reduced hospital stays, and improved postoperative pain control (Chaccour C, *et al.* 2023).

Despite these ongoing debates, since the approval of vNOTES devices in 2018, a growing number of gynaecologic surgeons have adopted vNOTES as a standard surgical approach. Three national Turkish

studies have reviewed the outcomes of vNOTES hysterectomy (Bekkers *et al.* 2024, Interdonato *et al.* 2022, Kim *et al.* 2020). Our findings were consistent with these reports regarding operative time, previous surgical history, haemoglobin drop, and mean VAS scores for postoperative pain. However, our study differed in two important aspects: patients in our series had higher mean body weights and uterine weights compared to those reported in other national studies.

In our cohort, approximately one-third of the participants were classified as obese, an unsurprising finding given that Turkey is among the most obese countries in Europe, with obesity prevalence comparable to that of the United States. Obesity is known to increase the risk of intraoperative vascular injury, venous thromboembolism, surgical site infection, and prolonged hospitalisation. Therefore, improving minimally invasive techniques such as laparoscopy is widely considered crucial to reduce obesity-related morbidities in gynaecologic surgery.

In obese women, VH is often preferred because it allows direct access to the peritoneal cavity via the cul-de-sac, which contains less adipose tissue than the abdominal wall. VH is also associated with lower complication rates compared to abdominal or laparoscopic approaches (ACOG Educational Bulletin 2017). Nonetheless, performing VH in obese patients can be technically challenging due to excessive vaginal tissue, prominent buttocks, or the absence of pelvic organ descent. Moreover, obesity contributes to various gynaecologic disorders by altering hormone-responsive tissues and increasing exposure to unopposed oestrogen, thereby predisposing women to abnormal uterine bleeding and endometrial hyperplasia (ACOG Educational Bulletin 2017). Consequently, obese patients frequently present with enlarged uteri and a higher incidence of endometrial carcinoma. These factors often make VH less practical in routine settings, leading many surgeons to favour conventional laparoscopic approaches. We believe that vNOTES may offer a valuable alternative in such cases.

Several studies comparing standard laparoscopic hysterectomy and vNOTES in obese patients have shown that vNOTES is associated with shorter operative durations, less postoperative pain, and shorter hospital stays (Baekelandt *et al.* 2019, Kaya *et al.* 2022, Matak *et al.* 2024). In our study, 15.0% of patients presented with an enlarged uterus. An enlarged uterus, commonly defined as exceeding the size of a 12-week pregnancy or weighing > 280 g, is traditionally considered a relative contraindication to vaginal surgery (Muffly and Kow 2014, Hong 2024). In such cases, abdominal hysterectomy is typically recommended due to the challenges posed by limited surgical field visibility, restricted instrument mobility, and difficulties in specimen removal. Moreover, performing surgery on a significantly enlarged uterus increases the risk of intraoperative conversion, potentially leading to prolonged operative time, increased blood loss, and the need for transfusion. However, NOTES hysterectomy appears to be a feasible alternative in patients with large uteri and displaced vascular pedicles (Hurni *et al.* 2024). We believe that this technique provides better access to the uterine vessels, thereby facilitating early haemostasis and reducing intraoperative blood loss.

Our study used three different pneumoperitoneum pressures—8, 10, and 12 mmHg. Compared to conventional laparoscopy, vNOTES can be performed at significantly lower pneumoperitoneum pressures (6–10 mmHg), as opposed to the traditional 12–14 mmHg used in standard laparoscopic procedures (Kim *et al.* 2020, Interdonato *et al.* 2022). This reduction in insufflation pressure decreases the duration and intensity of anaesthetic ventilation and may mitigate complications such as insufflation-induced bradycardia and excessive carbon dioxide absorption. These factors are particularly relevant for obese patients and those with compromised cardiopulmonary function.

VH is considered the least invasive and most cost-effective hysterectomy technique. Despite its well-established clinical benefits, modern gynaecologists, including recent graduates, often lack sufficient training in VH and thus may feel less confident offering it as a surgical option (Wright *et al.* 2013, Cain *et al.* 2025). We observed an increase in the number of VH procedures following the integration of vNOTES into our hysterectomy practice during the study period. A similar trend was reported by Ozceltik *et al.* who documented a significant rise in the proportion of vaginal hysterectomies, from 40.1% to 94.3%, after the adoption of vNOTES (Ozceltik *et al.* 2022).

While vNOTES is technically feasible in patients with a history of multiple pelvic-abdominal surgeries, its application is contraindicated in cases involving rectovaginal endometriosis, severe pelvic inflammatory disease, or previous pelvic radiotherapy. Thorough preoperative evaluation, including bimanual rectovaginal examination and transvaginal sonography with assessment of the sliding sign, is essential to

identify high-risk cases and minimise the risk of complications. In our study, the rates of intraoperative, postoperative, and conversion-related complications were 1.7%, 1.4%, and 0.9%, respectively. These rates were slightly lower than those reported in existing cohort studies (Stuart *et al.* 2025). Two main factors may account for this difference. First, all procedures were performed by highly experienced surgeons, each of whom had completed approximately 10 vNOTES cases to overcome the learning curve. Second, our follow-up period was limited to 4 weeks, as most patients were referred from remote areas, limiting the duration of postoperative observation.

This study had several limitations. It was retrospective in design and lacked a comparative evaluation group. Additionally, all participating centres were specialised referral units for gynaecological surgery, with all procedures being performed by experienced surgeons proficient in both laparoscopic and vaginal approaches, regardless of institutional setting. However, despite these limitations, our study benefitted from a robust dataset derived from accurate and well-organised medical records, clinical homogeneity among cases, a large sample size, and adherence to a standardised vNOTES surgical protocol across all centres.

In summary, vNOTES represents a safe and feasible surgical option that may overcome certain limitations associated with traditional laparoscopic hysterectomy and VH in selected cases. Further studies are warranted to evaluate the learning curve of surgeons with varying levels of expertise—novice, proficient, and expert—when adopting vNOTES into clinical practice.

Author contributions

CRediT: **Kemal Gungorduk**: Writing – original draft; **Yasam Kemal Akpak**: Data curation; **Koray Gorkem Sacinti**: Analysis; **Vakkas Korkmaz**: Data curation; **Serhan Can Iscan**: Data curation; **Ahkam Goksel Kanmaz**: Data curation; **Ghanim Khatib**: Data curation; **Bahadır Kosan**: Analysis; **Candost Hanedan**: Data curation; **Emrah Toz**: Analysis; **Varol Gülseren**: Data curation; **Salih Taskin**: Design; **Kemal Ozerkan**: Design; **Cagatay Taskiran**: Design.

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Data availability statement

The datasets generated and analysed during our study are not publicly available due to patient confidentiality and data protection regulations. However, they can be obtained from the corresponding author upon reasonable request.

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