Original Article

Transvaginal natural orifice specimen extraction surgery in simple nephrectomy

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ABSTRACT

Introduction: Natural orifice specimen extraction surgery (NOSES), particularly transvaginal NOSES, is an innovative approach in laparoscopic urological surgery. This study aims to assess the feasibility, safety, and outcomes of transvaginal NOSES in women undergoing laparoscopic simple nephrectomy in an Indian cohort.

Methods: A prospective observational study was conducted from September 2022 to May 2024 in the department of urology, including 15 women with prior vaginal deliveries undergoing simple nephrectomy. Exclusion criteria were vaginal scarring, previous pelvic surgeries, active intravaginal infections, cervical neoplasia, unresolved pelvic inflammation, and patient refusal. Parameters assessed included operative time, specimen extraction time, blood loss, postoperative recovery metrics, Female Sexual Function Index, and Pelvic Floor Impact Questionnaire scores at the baseline and at 3 months.

Results: The mean age of the patients was 45.73 years. The average operative time, including the specimen extraction was 127.8 min and the average extraction time was 30.13 min. None required conversion to open surgery, and the average blood loss was 68.0 mL with no intraoperative transfusions. The postoperative recovery was rapid, with milestones achieved within 1 day, and the average hospital stay was 2.2 days. Pain scores were low (Visual Analog Scale: 2.87 at 24 h and 1.47 at 48 h). The complication rate was 6.67%, with one case of vaginal bleeding which was managed conservatively. Postoperative pelvic floor and sexual functions were preserved without significant adverse effects.

Conclusion: Transvaginal NOSES is a feasible and safe technique for nephrectomy, offering reduced postoperative pain, minimal blood loss, and rapid recovery, enhancing surgical outcomes and patient satisfaction.

INTRODUCTION

Traditionally, nephrectomy was performed via open surgery, which required large incisions and caused significant tissue disruption, leading to extended hospital stays, increased postoperative pain, and higher complication rates.[1] The emergence of minimally invasive techniques, particularly laparoscopic nephrectomy, has greatly improved the patient outcomes by reducing the recovery time and complications. However, conventional laparoscopic approaches still require an additional abdominal incision for specimen extraction, posing risks of postoperative pain, infection, and herniation.

Natural orifice specimen extraction surgery (NOSES) has recently gained attention as an innovative approach that eliminates the need for abdominal incisions using natural orifices, such as the vagina, for specimen retrieval.[2-4] This technique may offer enhanced recovery by minimizing the surgical trauma, reducing the pain, and avoiding complications associated with abdominal wall incisions.

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NOSES also provides potential cosmetic benefits and preserves the integrity of the abdominal wall that is especially advantageous in patients undergoing repeat surgeries.

Despite promising preliminary outcomes, transvaginal NOSES in patients undergoing nephrectomy remains underreported, with limited cases and standardized protocols in the literature. This study aims to evaluate the technical feasibility, patient outcomes, and effectiveness of NOSES during nephrectomy, highlighting its role in reducing the surgical morbidity and aligning with personalized, patient-centered care approaches.[5-10]

MATERIALS AND METHODS

This prospective observational study was conducted in the department of urology from September 2022 to May 2024. The study was approved by the Institutional Ethics Committee vide letter number IEC/2022/4168 dated September 23, 2022. All women who met the study's inclusion and exclusion criteria during the specified period were consecutively enrolled, resulting in a total of 15 patients undergoing the NOSES procedure. The procedure adhered to the ethical guidelines of the Declaration of Helsinki and its amendments.

This study serves as an audit of a novel procedure, focusing on evaluating its feasibility, safety, and clinical outcomes. The parameters assessed included total operative time (minutes), time required for specimen extraction via the vagina (minutes), estimated intraoperative blood loss (mL), and associated complications. Additionally, postoperative recovery metrics were monitored, including time to first flatus (days), time to resumption of oral diet (days), time to ambulation (days), time to drainage tube removal (days), and duration of postoperative hospital stay (days). Specimen size was measured by its maximum diameter (cm). Pain scores were evaluated using the Visual Analog Scale (VAS) at 24 and 48 h postoperatively (scale 1–10). Functional outcomes were assessed using the Pelvic Floor Impact Questionnaire (PFIQ)-7 and the Female Sexual Function Index (FSFI), both recorded preoperatively and 3 months postoperatively.

Inclusion criteria

1. Female patients with a history of vaginal delivery undergoing simple nephrectomy were included.

Exclusion criteria

1. Patients with vaginal scarring or adhesions due to previous surgery
2. Patients with active intravaginal infection, cervical neoplasia or carcinogenesis, or gynecological pelvic inflammation that were not cured before surgery
3. Patients unwilling to participate in the study.

Patient baseline assessments, including demographic data, medical, obstetric, and gynecological history, physical examination, and radiological investigations, were meticulously documented. A PAP smear and gynecological consultation were conducted for all the patients, as supported by the literature, to identify any potential risks that might impact the surgical safety and outcomes. Each patient received counseling on the surgical procedure, including alternative specimen extraction methods, and informed written consent was obtained from all the participants. The authors confirm the availability of, and access to, all original data reported in this study.

Preoperative preparation

Vaginal preparation involved once-daily irrigation with povidone-iodine solution for 3 days preceding the operation. During the perioperative period, a single dose of ceftriaxone was administered at the time of the induction of anesthesia as a part of the routine antibiotic prophylaxis regimen.

Surgical methods

Preparation steps – under general anesthesia, the patient was placed in an oblique position of 70° [Figure 1].

Transvaginal natural orifice specimen extraction surgery

All patients underwent laparoscopic simple nephrectomy in a standard manner. Following simple nephrectomy, the specimen was placed in an endobag with its thread left long which was subsequently used for aiding removal through the vagina. In this study, an urobag was repurposed as an endobag for the specimen retrieval. The uterus was hitched to the anterior abdominal wall, and an additional 5-mm port was placed in triangulation with the pelvis to aid in suturing. The laparoscopic field of view was shifted to the pelvis. A sponge pad on the forceps was inserted into the vagina and was positioned firmly in the posterior fornix.

The posterior vaginal fornix was cut open for about 5–8 cm depending on the size of the specimen with the help of scissors or hook, and the long thread of the endobag was

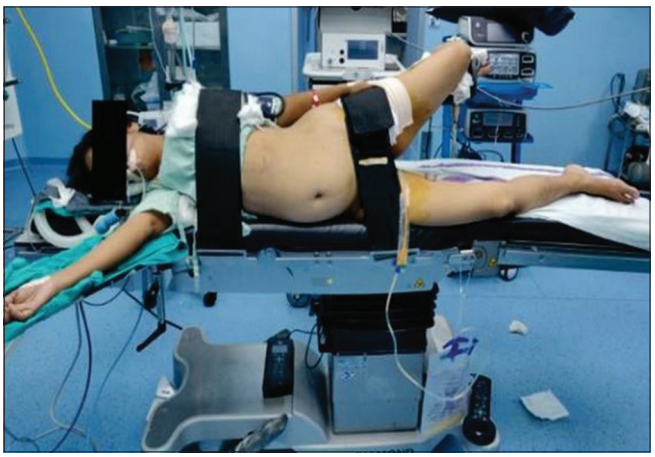

Figure 1: The positioning of the patient

grasped with the help of an artery forceps and retrieved out. The incision on the posterior vaginal fornix was sutured with 3-0 absorbable barbed suture in a continuous fashion laparoscopically. The entire surgical procedure was conducted with the patient maintained in a single position [Figure 2].

Follow-up protocol

All patients were scheduled for regular follow-up visits: at 2 weeks and 3 months postoperatively.

During the follow-up visits, the patients underwent physical examinations, evaluation of the wound healing, and monitoring for any signs of complications. At 3 months post-surgery, the PFIQ and sexual function scores were assessed.

Statistical analysis

The descriptive statistics were used to summarize the baseline characteristics of the study population. Continuous variables were reported as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Paired *t*-tests were performed to compare the preoperative and postoperative values for various parameters, including VAS scores, FSFI scores, and PFIQ scores.

The paired *t*-test was used to determine if there was a statistically significant difference between the means of the two related groups.

RESULTS

A total of 15 patients underwent transvaginal NOSES for nephrectomy, with a mean age of 45.73 years. Side of surgery was nearly equally distributed between the right and left. The most common indication was calculus disease, followed by primary PUJO (Pelviureteric junction obstruction) and chronic pyelonephritis. Most patients had no comorbidities, with hypertension and diabetes mellitus observed in a minority. Preoperative interventions, such as percutaneous nephrostomy, were performed in about one-third of the cases.

The procedure demonstrated favorable intraoperative and postoperative outcomes, with no conversions to open surgery and minimal blood loss. The mean time for specimen extraction was 30.13 min. However, with subsequent cases, the extraction time decreased to an average of about 20 min [Figure 3].

Postoperative recovery was rapid, with early ambulation, resumption of diet, and short hospital stay. Pain levels significantly decreased within 48 h postoperatively. Only one patient experienced a minor complication that was managed conservatively. Postoperative assessments showed stable or improved pelvic floor and sexual function scores, highlighting the safety and efficacy of the procedure in this cohort. The detailed demographic and procedural parameters are provided in Table 1.

DISCUSSION

In recent years, surgical practice has significantly evolved from conventional open surgery to minimally invasive approaches. The advent of laparoscopy has dramatically improved the postoperative outcomes, especially in renal surgery. Innovations such as laparo-endoscopic single-site surgery and natural orifice transluminal endoscopic surgery (NOTES) have recently emerged,

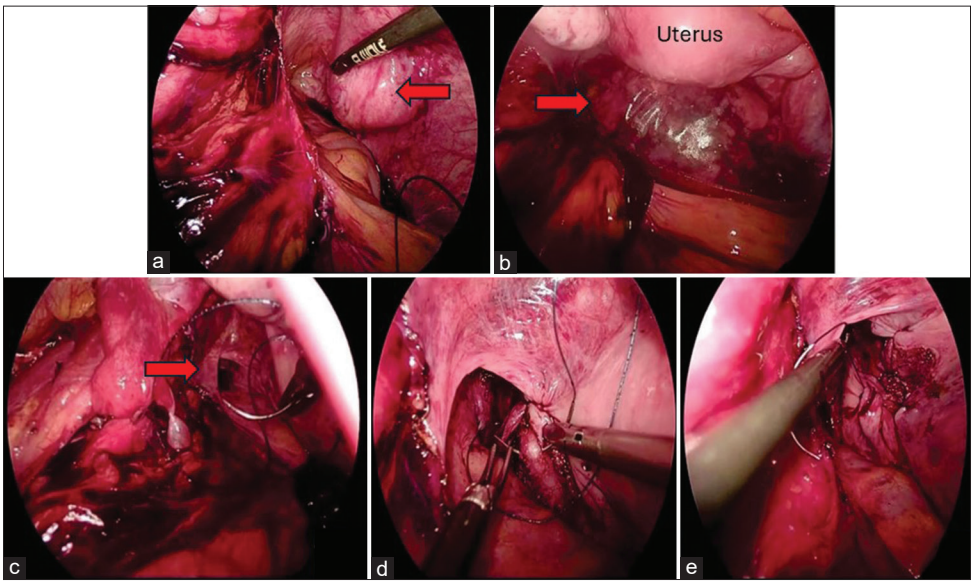

Figure 2: (a) Incision site on the posterior fornix (arrow) delineated by the surgical assistant. (b) The endobag (arrow) is delivered out via the incision. (c-e) The ensuing defect in the posterior fornix (arrow) is closed using a barbed suture

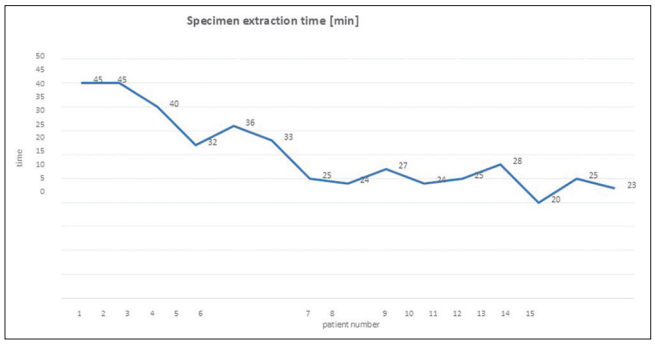

Figure 3: Specimen extraction time

providing enhanced cosmetic results while maintaining the functional and oncologic integrity.[9]

Despite its advantages, pure NOTES remains impractical for renal surgery due to the need of specialized instruments and learning curve associated with the procedure. Consequently, a hybrid approach combining the transvaginal and transabdominal accesses has been explored to address these limitations. The transvaginal NOSES approach offers a less invasive alternative for extracting large specimens without the need for extending the traditional incisions or creating additional incisions. The incidence of extraction site incisional hernia after the abdominal incisions has remained a concern over the years with reported rates reaching up to 12.6% after an average follow-up period of 5.9 years, based on the data from a substantial cohort of over 2000 patients.[11] The NOSES approach utilizes the vaginal natural orifice, leveraging its elastic and self-sealing properties to facilitate the specimen removal.[12]

In our study, the average operative time was 127.8 min. This is comparable to the findings of Zhao *et al*., who reported a mean total operative time of 133 min for the transvaginal NOSES during three-dimensional laparoscopic partial or radical nephrectomy, indicating similar efficiency in surgical performance.[13]

The average specimen extraction time in our study was 30.13 min. Gill *et al*. reported an average specimen extraction time of 35 min while Zhao *et al*. reported an average NOSES time of 15 min, which is notably shorter than our findings.[2,13] Hwang *et al*. found a mean operative time of 28.3 min for transvaginal NOSES in large organ surgeries, of which 33 were nephrectomies.[14] Our findings indicated that the average operative time for transvaginal NOSES was comparable to or slightly longer than the conventional methods. This reflects the additional steps involved in transvaginal specimen retrieval. Notably, the average specimen extraction time decreased significantly as the surgeon gained familiarity with positioning and suturing techniques, reducing to an average of 20 min, comparable to open extraction methods [Figure 3]. This variation in extraction times across the different studies can be attributed to the differences in the techniques used for closing the posterior colpotomy—whether transvaginal or intracorporeal—as well as the surgical expertise of the operating surgeon. Initially, the extraction times were longer, but they decreased with surgical experience. These findings align with existing literature supporting the feasibility and efficacy of transvaginal NOSES during nephrectomy.[15,16]

Table 1: Demographic data and preoperative and postoperative parameters

Parameters	Values
Age (years), mean±SD	45.73±11.50
Side (right/left)	7 right and 8 left
Indication	
Calculus disease	9
Primary PUJO	3
Chronic pyelonephritis	2
Secondary PUJO	1
Comorbidities	
None	11
HTN	2
DM	2
Preoperative PCN (%)	5 (33.33)
History of ipsilateral surgery	
Endourological	2
Open pyelolithotomies	2
BMI, mean±SD	20.93±2.31
Intraoperative parameters	
Parameter	**Mean (range)**
OT time (min)	127.8 (95–180)
Specimen extraction time (min)	30.13 (45–25)
Specimen size (cm)	
Length	10.66 (7–15)
Breadth	9.00 (4–10)
Width	8.73 (4–10)
Conversion to open surgery (%)	0
Blood loss (mL)	68.0 (40–100)
Intraoperative blood transfusion (%)	0
Postoperative parameters	
Parameter	**Mean**
Time to flatus (days)	1
Time to oral diet (days)	1
Time to ambulation (days)	1
Drain removal day	1.47
Intravenous analgesic requirement (days)	1.07
Time to return to activity (days)	5.4
Clavien-Dindo classification	
None	14
Grade 1	1
VAS, FSFI, and PFIQ scores	
Parameters	**Mean±SD**	***P***
VAS at 24 h	2.87±0.64	<0.0001
VAS at 48 h	1.47±0.52	
FSFI score preoperative	23.93±10.22	0.0192
FSFI score postoperative	24.6±10.4	
PFIQ preoperative	32.73±25.97	0.015
PFIQ postoperative	30.53±24.83	

VAS=Visual Analog Scale, FSFI=Female Sexual Function Index, PFIQ=Pelvic Floor Impact Questionnaire, SD=Standard deviation, BMI=Body mass index, HTN=Hypertension, DM=Diabetes mellitus, PCN=Percutaneous nephrostomy, OT=Operative time, PUJO=Pelviureteric junction obstruction

We observed an average blood loss of 68.0 mL with no conversions to the open surgery in our study and no requirement of intraoperative blood transfusions. Similarly, Gill *et al*. and Zhao *et al*. reported no conversions to open surgical extraction and minimal blood loss, consistent with our findings. This aspect is crucial in reducing the perioperative complications and enhancing the postoperative recovery and emphasizes the overall safety of the NOSES technique during nephrectomy.[2,13]

Our study demonstrated rapid postoperative recovery, with patients achieving milestones such as time to flatus, oral diet, and ambulation within 1.0 day each, and discharge at 2.2 days. Zhao *et al*. reported similar outcomes but observed a slightly longer duration of hospital stay of 5 days. Despite this extended duration of hospital stay as compared to our findings, the study still demonstrated swifter recovery milestones, which are indicative of reduced surgical trauma and enhanced post-operative patient comfort.[13]

Postoperative pain management is a cornerstone of patient care following any surgical intervention. Patients in our study reported low average pain scores (VAS) of 2.87 at 24 h and 1.47 at 48 h postsurgery. Zhao *et al*. similarly reported mean visual analog scores of 3 and 1 at 24 and 48 h, respectively, closely matching our pain management outcomes.[13] Alcaraz *et al*. and Gurluler *et al*. also found lower postoperative pain scores and reduced analgesic drug use in the NOSES group, consistent with the pain relief observed in our study.[17,18] The minimal pain experienced by the patients reflects the benefits of a less invasive approach, which typically results in reduced surgical trauma compared to the conventional methods. This aspect not only promotes early recovery but also enhances the patient comfort and satisfaction during the immediate postoperative period.

Technical considerations such as the size of the specimen, selection criteria of the patients, and preoperative assessment of the vagina all play pivotal role in determining the feasibility and success of transvaginal NOSES. In our study, we were successfully able to extract all the specimens transvaginally with an average size of 10.66 cm × 9 cm × 8.73 cm (length × breadth × width), whereas Zhao *et al*. reported the average specimen size as 6 cm in their study.[13] Hwang *et al*. reported conversion to open surgical extraction in 15.7% (8/51) of the cases due to unanticipated intraoperative conditions, such as inability to perform the posterior colpotomy due to an inaccessible posterior cul-de-sac, severe pelvic adhesions despite no history of prior surgery, and a relatively narrow vaginal cavity in comparison to the bulky specimen.[14] The success of transvaginal NOSE is influenced by various patient factors, such as the body mass index (BMI), medical comorbidities, and surgical history. Patients with high BMI tend to have increased visceral fat, leading to larger specimens and potential failure of the procedure. Additionally, patients with multiple comorbidities are more susceptible to complications, and prior surgeries or radiation exposure may affect the feasibility of transvaginal NOSES. Therefore, emphasis on strict patient selection criteria, preoperative gynecological assessment, evaluation of the specimen characteristics, including diameter and shape, play a critical role in the success of the procedure.[14,16]

We reported a complication rate of 6.67%, with only one case of postoperative vaginal bleeding from the suture site which was managed conservatively. Similar findings were noted by Gill *et al*. where one patient had vaginal spotting which resolved conservatively; Zhao *et al*. reported no postoperative complications.[2,13] Regarding the risk of infection, none of our patients experienced suture line infection following the transvaginal specimen extraction, consistent with the existing literature indicating that this method is safer when proper sterilization and antibiotic protocols are followed. Despite initial concerns about contamination, the vaginal route has been demonstrated to be a safe pathway for specimen extraction when managed appropriately.

Our study indicated stable pelvic floor function (PFIQ score: 32.73 preoperative, 30.53 postoperative) and no adverse effect on the sexual functions (FSFI score: 23.93 preoperative, 24.6 postoperative). Postoperatively, the average FSFI score slightly increased to 24.6, suggesting an improvement or maintenance of the sexual function following the surgery. This implies that the NOSES technique did not adversely affect the sexual functions, and the slight improvement noted in the scores could be attributed to the general well-being of the patients, post-surgery. PFIQ scores evaluate the impact of pelvic floor disorders on a patient's quality of life, considering factors such as urinary, bowel, and prolapse symptoms. The average pre-operative score was 32.73, reflecting the degree of pelvic floor-related symptoms and their impact on the daily life before the surgery. Postoperatively, the average PFIQ score decreased to 30.53, indicating that transvaginal extraction of the specimen did not adversely affect the pelvic floor function in the patients and did not result in any new-onset pelvic floor dysfunction. These outcomes align with Zhao *et al*. and Hwang *et al*. who reported high patient satisfaction levels post-NOSES nephrectomy with minimal impact on the pelvic floor function and sexual health.[13,14,19] The comparison between the different studies is provided in Table 2.

Despite the existing literature on the transvaginal NOSES, it has not achieved widespread global acceptance. Key factors limiting the global adoption of NOSES include the challenges related to the patient positioning, the additional time required for the specimen extraction, and the learning curve associated with intracorporeal suturing in the modified lateral position. Additionally, proper patient

Table 2: Comparison between our study and existing literature

Parameters (average)	Our study	Gill *et al*.[2]	Zhao *et al*.[13]	Hwang *et al*.[14]
Age (years), mean±SD	45.73±11.50	67 (39–87)*	66.7±8.6	57.6±14.1
BMI, mean±SD	20.93±2.31	24	23.5±3.7	23.5±2.7
OT (min), mean±SD	127.8 (95–180)*	195	139.4±48.9	233
Specimen extraction time (min), mean±SD	30.13 (45–25)*	35	14.6±2.7	28.3
Blood loss (mL)	68.0 (40–100)*	100	12.1±5.1	163
Conversion to open extraction (%)	0	0	0	8/51 (15.7)
Postoperative hospital stay (days)	2.2	1	6.5±1.7	6.7
Pain scores (VAS) (h)				
24	2.87±0.64	N/A	2.9±0.7	4.9±1.8
48	1.47±0.52		1.3±0.6	3.5±1.8
Complication rate (%)	6.67	10	0	7.9
Impact on pelvic floor Function	PFIQ-7	No adverse impact reported	PFDI - 20	N/A
Preoperative	32.73±25.97	Scores not calculated	6.25±1.75	
Postoperative	30.53±24.83		6.3±1.8	
Impact on sexual function	FSFI	No adverse impact		
Preoperative	23.93±10.22	reported	28.5±4.0	-
Postoperative	24.6±10.40	Scores not calculated	28.3±3.5	21.2±8.7

*Range. SD=Standard deviation, BMI=Body mass index, VAS=Visual Analog Scale, OT=Operative time, N/A=Not available, PFIQ=Pelvic Floor Impact Questionnaire, PFDI=Pelvic Floor Distress Inventory, FSFI=Female Sexual Function Index

selection criteria, comprehensive preoperative gynecological examination, and meticulous planning are essential for the success of this procedure. Identifying suitable candidates involves assessing factors such as vaginal elasticity, history of previous vaginal deliveries, and absence of significant vaginal scarring.[20-22]

One of the primary limitations of our study is the relatively small sample size of 15 patients, which may limit the generalizability of the findings. Future studies involving comparative analyses are being considered to strengthen these findings. Conducting the study at a single center introduces potential biases and restricts the external validity of the results. Multi-center studies are needed to provide more robust evidence by incorporating variability in the surgical techniques, patient demographics, and healthcare practices. Additionally, our study focused on short-term outcomes and lacked long-term follow-up data. Longitudinal studies are crucial to evaluate the durability of surgical outcomes, including long-term pelvic floor function, and impacts on sexual health.

Despite the limitations, this study is, to our knowledge, the first to evaluate the role of transvaginal NOSES during simple nephrectomy among Indian patients. Given the novel nature of NOSES and its potential impact on the patient privacy and bodily integrity, it is imperative for surgeons to conduct comprehensive preoperative counseling. This ensures that patients have a clear understanding of the procedure and its implications before providing the consent.

CONCLUSION

Transvaginal NOSES demonstrates promising potential in nephrectomy, enhancing the surgical outcomes, facilitating rapid recovery, and improving the patient's quality of life. The study confirms its feasibility with an average operative time of 127.8 min and efficient specimen extraction within 30.13 min, accompanied by reduced postoperative pain and shorter hospital stays. These results highlight its role in achieving early postoperative milestones and high patient satisfaction. Further research with larger cohorts and multicenter studies is essential to validate these findings, refine the technique, and expand the indications for safe integration of transvaginal NOSES into routine urological practice.

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