RESEARCH ARTICLE

Clinical Outcomes of TU-LESS Combined with Extracorporeal Operation in Benign Adnexal Masses: A Retrospective Study

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Abstract

Objective: To investigate the clinical effect of transumbilical laparoendoscopic single-site surgery integrated with extracorporeal operation mode for treating benign adnexal masses.

Method: The retrospective study was conducted in October 2024 at the Maternity and Child Care Centre, Qinhuangdao, China, and comprised data of female patients with benign adnexal masses admitted from January 2022 to September 2024. The patients were randomised into two groups, with group A controls receiving conventional multi-port laparoscopic surgery, and intervention group B undergoing transumbilical laparoendoscopic single-site surgery with extracorporeal surgical mode. Intraoperative condition, postoperative rehabilitation, complication incidence, inflammatory cytokine levels and quality of life scores were compared between the groups. Data was analysed using SPSS 25.

Results: Of the 60 female patients, 30(50%) were in group A having mean age 32.38±5.21 years, and the remaining 30(50%) were in group B with mean age 32.38±5.21 years. There was no significant intergroup difference between the groups at baseline ($p>0.05$). There was no significant difference in intraoperative bleeding and surgical time between the groups ($p>0.05$). Group B showed significantly shorter postoperative anal exhaust time, ambulation time and hospitalisation duration as well as lower complication rates compared to group A ($p<0.05$). The average levels of interleukin-6, high-sensitivity C-reactive protein and tumour necrosis factor-alpha in group B were lower than those in group A 24 hours after surgery ($p<0.05$). The quality of life was higher in group B than group A ($p<0.05$)

Conclusion: The transumbilical laparoendoscopic single-site surgery integrated with extracorporeal operation mode could reduce surgical trauma, shorten postoperative recovery process, inhibit inflammatory response, and improve patients' quality of life.

Keywords: Transumbilical laparoendoscopic single-site surgery, Extracorporeal operation mode, Traditional multi-port laparoscopic surgery, Benign adnexal mass, Postoperative rehabilitation, Complications, Quality of life. (JPMA 76: 851; 2026) **DOI: https://doi.org/10.47391/JPMA.22526**

Introduction

Female benign adnexal diseases generally include ovarian cysts, mesosalpinx cysts, and oviduct ovarian cysts, with a high incidence in women aged 20-50 years.[1,2] Most patients have no symptoms in the early stages, but may feel abdominal distention or palpable lumps in the abdomen as the mass grows. If the mass grows >10cm in size, there may be pressure symptoms, such as frequent urination, constipation, shortness of breath, palpitations, etc. Surgery is the first choice for the treatment of the condition.[3] Compared with laparotomy, laparoscopic surgery has the advantages of faster postoperative recovery, minimal trauma and fewer perioperative complications[4,5] and is, therefore, widely used for treating benign and malignant gynaecological diseases. At present, traditional multi-port laparoscopic surgery (MPLS) is the typical technique of minimally invasive gynaecological surgery. Natural Orifice Endoscopic Surgery (NOTES) has gradually been applied clinically with the advancement of technology and in line with the Enhanced Recovery After Surgery (ERAS) concept. NOTES is a surgical technique that uses the natural orifice of the human body as the entrance.[6] Transumbilical laparoendoscopic single-site surgery (TU-LESS) is a common approach for gynaecological endoscopic surgery via the natural orifice currently, which has been a common surgical procedure for the resection of benign adnexal masses.[6] This surgical technique has the advantages of smaller trauma and occult scars, and it is increasingly being favoured by women as well as clinical physicians. However, its clinical application has revealed several shortcomings of TU-LESS,[7] mainly including technical difficulty, restrictions in imaging equipment and surgical instruments, and limited indications. In response to existing problems and adverse factors of laparoendoscopic single-

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site surgery, it is feasible and effective to expose the lesion outside the lap-protector, or pull the lesion under the incision to perform fine operations, such as cutting, separating and suturing manually under direct visualisation, just similar to those in traditional laparotomy, which is more conducive to reducing surgical difficulty.[8]

In contrast to such technical limitations of TU-LESS, hybrid approaches combining extracorporeal techniques seem promising. The current study was planned to addresses the critical gap in literature regrading evidence in favour of the hybrid approach by evaluating the comprehensive therapeutic effect of TU-LESS combined with extracorporeal operation mode on patients with benign adnexal masses.

Materials and Methods

The retrospective study was conducted in October 2024 at the Maternity and Child Care Centre, Qinhuangdao, China, and comprised data of female patients with benign adnexal masses admitted from January 2022 to September 2024. After approval from the institutional ethics review committee, the sample size was determined based on the number of eligible patients admitted during the specified period. The sample was raised using consecutive sampling technique. Those included were patients aged 22-40 years who had been diagnosed with benign adnexal masses through ultrasound examination, and who underwent laparoscopic surgery with corresponding indications for surgery. Patients with a history of severe pelvic infection, peritonitis and other surgical contraindications, those with severe pelvic endometriosis, patients who experienced serious postoperative complications and required intensive care unit (ICU) monitoring and treatment, and those with missing outcome data were excluded. Informed consent had been obtained from all the patients and their family members at the time of surgery, and those who did not consent to participate in the study were excluded. The patients were randomised into two groups using the random number table method, with group A controls receiving conventional MPLS, and intervention group B undergoing TU-LESS with extracorporeal surgical mode. A TU-LESS system (Beijing HangTian KaDi Technology R&D Institute, China), an optical imaging system (Karl Storz), as well as dissecting forceps, surgical scissors, single-pole electric hook, bipolar forceps, needle holder, ultrasonic knife and other auxiliary operating instruments (Kangji, Hangzhou, China) were used.

The patients fasted from solids for 6 hours and liquids for 2 hours preoperatively. They were asked to drink 200mL of Mizone beverage (energy: 90kJ/100mL) 2h before surgery. Also, the patients were required to drink 2,000mL of warm water and 2 boxes of polyethylene glycol electrolytes powder (I) orally in 2 doses within 24h before surgery. They were given unconventional enemas using warm soap water before surgery. The American Society of Anaesthesiologists (ASA) classification[9] was used to assess anaesthesia fitness of the patients.

In MPLS group A, after preoperative examinations, the patients underwent general anaesthesia and were placed in a supine position (Trendelenburg position), with a urinary catheter placed. After establishing artificial pneumoperitoneum (12-14mmHg) via trocars placed at the navel the, McBurney point, the midpoint between the inverse McBurney point and the navel, and the abdominal and pelvic cavities were explored. The adnexal masses were excised using standard laparoscopic techniques, with haemostasis achieved by electrocoagulation or suture. For adnexectomy, the affected adnexa was removed by coagulating and cutting the supporting ligaments. Specimens were retrieved in a bag through a 10mm port and sent for frozen-section analysis. Incisions were closed after confirming benign pathology.

Group B patients were provided with a combined therapy of TU-LESS and extracorporeal operation. After various preoperative examinations, the patients underwent general anaesthesia and were placed in a supine position (Trendelenburg position), with a urinary catheter placed. A single 2.5-3cm umbilical incision was made, and a lap-protector was inserted. After laparoscopic exploration, the adnexal mass was exteriorised through the umbilical incision. Under direct vision, cystectomy or adnexectomy was performed using the same surgical principles as in group A. The ovary (if preserved) was returned to the abdominal cavity, and the incision was closed.

All the surgeries were performed by the same surgical team to ensure consistency. The outcome assessors were blinded to the group allocation during data collection and analysis.

Surgical parameters, including intraoperative blood loss and duration of the procedure, were noted in both the cohorts. Relevant factors, such as anal exhaust time, out-of-bed activity, and length of hospital stay (LOS), were compared between the groups. The incidence of complications, like incision infection, urinary retention, postoperative bleeding, and lower limb vein thrombosis, were also compared. After sampling 6ml cubital venous blood from each patient under fasting state into two anticoagulant tubes, the samples were centrifuged using a high-speed centrifuge (AC-80F, KHB, Shanghai, Medical Instrument; approved [No.1410703] by Shanghai Municipal Food and Drug Administration [2014]). Levels of inflammatory cytokines interleukin-6 (IL-6), high-

sensitivity-C-reactive protein (hs-CRP), and tumour necrosis factor-alpha (TNF-α) were quantified using commercially available, validated enzyme-linked immunosorbent assay (ELISA) kits (Xi'an IVD Biotechnology Co., Ltd., China) as per the manufacturer's instructions. The assays were performed using a multimode reader (SM600, Utrao, Shanghai, Medical Instrument; approved [No.2400984] by Shanghai Municipal Food and Drug Administration [2013]). The kits demonstrated appropriate sensitivity, specificity and precision and were executed as per the manufacturer's instructions. Before surgery and at discharge, patients' quality of life (QOL) was assessed using the validated Generic Quality of Life Inventory-74 (GQOLI-74),[10] which evaluated physical, psychological and social functions, as well as the surrounding environment, with higher scores indicating better QOL.

Data was analysed using SPSS 25. Continuous variables were reported as mean±standard deviation, while categorical variables were reported as frequencies and percentages. The comparison of continuous variables was carried out using t-test, and chi-square test was employed for categorical variables. Given the exploratory nature of the study and distinct clinical domains of outcome measures (inflammatory response vs. QOL represent separate biological pathways),[11,12] adjustment was not made for multiple comparisons. This approach aligned with similar surgical studies evaluating multidimensional outcomes.[13] P<0.05 was considered statistically significant.

Results

Of the 60 female patients, 30(50%) were in control group A having mean age 32.38±5.21 years, body mass index (BMI) 22.65±2.89kg/m^2, and mean adnexal mass diameter 10.55±5.25 cm. There were 15(50%) cases of ovarian cysts, 9(30%) of mesosalpinx cysts and 6(20%) of oviduct ovarian cysts. There were 21(70%) cases of ASA grade I and 9(30%) of grade II. The remaining 30(50%) patients were in group B with mean age 32.38±5.21 years, BMI 22.65±2.89kg/m^2, and adnexal mass diameter 10.50±4.85cm. There were 17(56.7%) cases of ovarian cysts, 8(26.7%) of mesosalpinx cysts and 5(16.6%) of oviductal ovarian cysts. ASA grade I was noted in 19(63.3%) cases and grade II in 11(36.7%). There was no significant difference in the baseline data of the two cohorts (p>0.05).

There was no significant difference in intraoperative bleeding and surgical time between the groups (p>0.05) (Table 1).

Group B showed significantly shorter postoperative anal exhaust time, ambulation time and LOS compared to group A (p<0.05) (Table 2).

Postoperative complications were noted in 2(6.67%) patients in group B compared to 4(13.33%) in group A (p>0.05) (Table 3).

The levels of hs-CRP, IL-6 and TNF-α in group B were lower than those in group A 24 hours post-surgery (p<0.05) (Table 4).

GQOLI-74 domain and totals scores in group B were greater than those in group A (p<0.05) (Table 5).

Table-1: Intergroup comparison of intraoperative indices.

Groups	Cases	Intraoperative blood loss (ml)	Operation time (min)
Observation group	30	45.32±8.72	60.21±7.29
Control group	30	49.12±9.19	62.08±8.37
Statistical value		1.642	0.923
p-value		0.106	0.360
95%CI		-8.43-0.83	-5.93-2.19

CI: Confidence interval.

Table-2: Intergroup comparison of postoperative rehabilitation-related indices.

Groups	Cases	Postoperative anal exhaust duration (h)	Postoperative out-of-bed activity duration (h)	Length of hospital stay (d)
Observation group	30	16.23±4.98	20.37±5.22	3.15±0.93
Control group	30	21.76±5.86	26.83±5.92	4.23±1.02
Statistical value		4.192	5.198	5.172
P value		<0.001	<0.001	<0.001
95%CI		-8.34- -2.72	-9.35- -3.57	-1.59- -0.58

CI: Confidence interval.

Table-3: Intergroup comparison of the incidence of complications.

Groups	Cases	Incision infection	Urinary retention	Postoperative bleeding	Lower limb venous thrombosis	Overall incidence
Observation group	30	0 (0.00)	1 (3.33)	1 (3.33)	0 (0.00)	2 (6.67)
Control group	30	1 (3.33)	1 (3.33)	1 (3.33)	1 (3.33)	4 (13.33)
Statistical value						0.741
p-value						0.389

Table-4: Intergroup comparison of inflammatory cytokine levels.

Groups	Cases	IL-6 (ng/ml)		hs-CRP (pg/ml)		TNF-α (ng/ml)	
		Prior to surgery	24h after surgery	Prior to surgery	24h after surgery	Prior to surgery	24h after surgery
Observation group	30	67.28±7.20	33.73±5.09*	39.13±4.98	14.98±3.93*	90.45±9.24	48.94±5.73*
Control group	30	68.19±6.83	40.10±5.72*	40.17±5.27	19.80±4.04*	91.76±9.05	53.87±6.06*
Statistical value		0.502	4.557	0.786	4.684	0.555	3.238
p-value		0.617	<0.001	0.435	<0.001	0.581	0.002
95%CI		-4.54-2.72	-9.17- -3.57	-3.69-1.61	-6.88- -2.76	-6.03-3.41	-7.98- -1.88

CI: Confidence interval; *p<0.05 vs. pre-surgery within group; p-values unadjusted for multiple comparisons due to distinct clinical domains.

Table-5: Intergroup comparison of wellbeing score.

Groups	Cases	Physical function		Psychological function		Social function		Surrounding environment		Total	
		Prior to surgery	At discharge	Prior to surgery	At discharge	Prior to surgery	At discharge	Prior to surgery	At discharge	Prior to surgery	At discharge
Observation group	30	59.73±5.91	85.23±8.22*	61.33±6.12	82.90±8.03*	61.15±6.14	84.93±8.62*	60.12±6.05	81.93±8.87*	242.34±23.11	335.00±32.90
Control group	30	60.82±6.04	79.30±7.93*	60.38±6.14	76.40±7.94*	62.76±6.58	78.40±7.85*	58.73±6.14	74.34±7.87*	242.70±24.14	308.44±31.54
Statistical value		0.704	2.844	0.600	3.152	0.980	3.068	0.881	3.506	0.059	3.192
P value		0.484	0.006	0.551	0.003	0.331	0.003	0.382	0.001	0.953	0.002
95%CI		-4.18-2.00	1.76-10.11	-2.22-4.12	2.37-10.63	-4.90-1.68	2.27-10.80	-1.76-4.54	3.26-11.93	-12.57-11.85	9.91-43.21

*$p<0.05$ compared with pre-surgery within group; CI: Confidence interval.

Discussion

Benign adnexal masses, like ovarian cysts, mesosalpinx cysts, oviduct ovarian cysts, etc., are common gynaecological diseases that are frequently seen in clinics. The pathogenesis of benign ovarian masses is considered to be multifactorial, generally involving aging, mental disorders, and endocrine disorders.[11,14] Active and effective interventions are required for patients diagnosed with benign adnexal masses, and surgical resection can prevent the deterioration of the condition. Laparotomy facilitates direct visualisation of mass location, morphology identification, and thorough mass removal. It also prevents tumour recurrence, and protects female adnexa. However, it may induce great trauma to the abdomen and uterus, scarring, and prolonged recovery time that may cause discomfort to patients. In recent decades, with the advancement of minimally invasive surgical techniques, there has been a continuous increase in the application of laparoscopic surgery, especially TU-LESS, for benign adnexal masses.[12,15] Nevertheless, it shall be acknowledged that TU-LESS also has shortcomings, such as technique difficulty of surgical procedures, small surgical field of vision, and unstable accuracy of surgical operations.[16] Moreover, due to a limited range of indications, overweight patients and those with repeated pelvic surgeries are usually not eligible for this surgical treatment.[17] It highlights a requirement for modification and improvement to TU-LESS to further improve surgical outcomes.

In the current study, patients in the observation group were provided with TU-LESS combined with ext.

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References

1. Sa SW, Guo T, Ma QH. The minimally invasive surgery for a giant benign adnexal cyst: a video vignette. Asian J Surg. 2024;47:1146. doi:10.1016/j.asjsur.2023.11.004
2. Cong R, Xue Y, Li Y, Li Q, Zhao L. Robotic transumbilical single-site re-staging surgery of ovarian granulosa cell tumor: case report and technical points with video. Ann Med Surg. (Lond) 2025;87:2358-61. doi:10.1097/MS9.0000000000002862
3. Xiao X, Liu T, Li X, He L, Lin Y, Feng D. Transvaginal natural orifice transluminal endoscopic surgery for tubal ectopic pregnancy (vNOTES-TEP): a protocol for a randomized controlled trial. BMC Pregnancy Childbirth. 2025;25:477. doi:10.1186/s12884-025-07595-z
4. Shan S, Zhao S, Wang X. Transumbilical laparoendoscopic single-site surgery vs multiport laparoscopic surgery for benign ovarian cysts: a retrospective cohort study. BMC Surg. 2024;24:399. doi:10.1186/s12893-024-02710-x
5. Peng S, Deng C, Chen J, Liu Z, Cui J, Liu S, et al. TU-LESS procedure for acute abdomen in late pregnancy: a retrospective study. Arch Gynecol Obstet. 2024;310:713-8. doi:10.1007/s00404-024-07573-4
6. Li F, Zheng Y, Chen S, Wang Q, Wang K, Yang F, et al. Role of transumbilical laparoendoscopic single-site surgery in the implementation of ERAS in gynecologic oncology: a retrospective study. Front Oncol. 2025;15:1483878. doi:10.3389/fonc.2025.1483878
7. Yuan W, Yang F, Zheng Y. Perioperative outcomes of transvaginal natural orifice transluminal endoscopic surgery and transumbilical laparoendoscopic single-site surgery in hysterectomy: a comparative study. Int J Gynaecol Obstet. 2024;165:1151-7. doi:10.1002/ijgo.15323
8. Weyl A, Chantalat E, Daniel G, Bordier B, Chaynes P, Doumerc N, et al. Transvaginal minimally invasive approach: an update on safety from an anatomical, anatomopathological and clinical point of view. J Gynecol Obstet Hum Reprod. 2021;50:101941. doi:10.1016/j.jogoh.2020.101941
9. Jenkins ES, Crooks R, Sauro K, Nelson G. Enhanced recovery after surgery (ERAS)-guided gynecologic oncology surgery: the patient's perspective. Gynecol Oncol Rep. 2024;55:101510. doi:10.1016/j.gore.2024.101510
10. Chen H, Li X, Xiong M, Yang L, Tao Y, Wen W, et al. Investigation of the application of enhanced recovery after surgery (ERAS) in elderly patients undergoing surgery for kidney stones. Am J Transl Res 2024;16:1711-20
11. Bender R, Lange S. Adjusting for multiple testing—when and how? J Clin Epidemiol 2001;54:343-9. doi:10.1016/S0895-4356(00)00314-0
12. Streiner DL. Best (but oft-forgotten) practices: the multiple problems of multiplicity—whether and how to correct for many statistical tests. Am J Clin Nutr. 2015;102:721-8. doi:10.3945/ajcn.115.113548
13. Streiner DL. Best (but oft-forgotten) practices: the multiple problems of multiplicity—whether and how to correct for many statistical

tests. Am J Clin Nutr. 2015;102:721-8. doi:10.3945/ajcn.115.113548 (Ref # 12 is Same)

14. Ishikawa Y, Nakanishi K, Tsumura A, Murakami K, Nishiwaki K. Early abdominal wall ectopic pregnancy treated with laparoscopic surgery: a case report and literature review. J Obstet Gynaecol Res. 2023;49:2544-8. doi:10.1111/jog.15739
15. Le Neveu M, Davis J, Nicholson R, Gough EK, Xie S, Patzkowsky K, et al. Reevaluating the requirement to void following minimally invasive hysterectomy: a randomized controlled trial. Am J Obstet Gynecol 2025;233:e11-5. doi:10.1016/j.ajog.2025.03.038
16. Yun JH, Horrow MM, Goykhman I, Rodgers SK. The confounding ultrasound diagnosis of ectopic pregnancy: lessons from peer learning. Ultrasound Q 2022;38:272-83. doi:10.1097/RUQ.0000000000000608
17. Huang J, Zuo X, Sun Y, Wu X, Zhu H, Cui W. Ectopic pregnancy adjacent to iliac vessels managed successfully by minimally invasive treatment using local methotrexate injection: an extremely rare case and literature review. J Gynecol Obstet Hum Reprod 2023;52:102691. doi:10.1016/j.jogoh.2023.102691
18. Jenabi E, Ayubi E, Khazaei S, Soltanian AR, Salehi AM. The environmental risk factors associated with ectopic pregnancy: an umbrella review. J Gynecol Obstet Hum Reprod 2023;52:102532. doi:10.1016/j.jogoh.2022.102532
19. Solangon SA, van Wely M, van Mello N, Mol BW, Ross JA, Jurkovic D. Methotrexate vs expectant management for treatment of tubal ectopic pregnancy: an individual participant data meta-analysis. Acta Obstet Gynecol Scand 2023;102:1159-75. doi:10.1111/aogs.14617
20. Załęcka J, Pankiewicz K, Issat T, Laudański P. Molecular mechanisms underlying the association between endometriosis and ectopic pregnancy. Int J Mol Sci 2022;23:3490. doi:10.3390/ijms23073490
21. Blajovan MD, Abu-Awwad A, Pop DL, Abu-Awwad SA, Tudoran C, Gurgus D, et al. Minimally invasive vs open synovectomy in rheumatoid arthritis: insights into clinical recovery, systemic inflammation, and economic impact. J Clin Med 2025;14:1519. doi:10.3390/jcm14051519
22. Zhu S, Yang S, Chen Y, Niu MM, Wang J, Li J, et al. Identification of a novel and high-affinity MIF inhibitor via structure-based pharmacophore modelling, molecular docking, molecular dynamics simulations, and biological evaluation. J Enzyme Inhib Med Chem 2025;40:2501378. doi:10.1080/14756366.2025.2501378
23. Zhao J, Wang X, Shu R, Yang F. Enhancing quality of life, mental health, and treatment adherence in patients who had undergone radical prostatectomy through an internet-supported home-based rehabilitation program. Arch Esp Urol 2025;78:310-7. doi:10.56434/j.arch.esp.urol.20257803.42

Author Contribution:

YW: Design, preparation, final approval and agreement to be accountable for all aspects of the work.
BS & YH: Drafting, revision and final approval.
TW & LG: Significantly revision and final approval.