DOI: https://doi.org/10.53350/pjmhs020231711605

ORIGINAL ARTICLE

Role of Intraoperative Ultrasound in Minimizing Anaesthetic Exposure during High-Risk Gynecologic Surgeries

NUZAHAT NAZAR CHEEMA[1], SHAZMA EJAZ[2], MAMOONA SHAIKH[3], SUMMAR FATIMA[4], SANIYA NAHEED[5], TAHIR BAIG[6]
[1]*Consultant Gynaecologist, Noor General Hospital, G-11 Markaz, Islamabad.*
[2]*Assistant Professor, Gyaecology & Obstetrics, Akhtar Saeed Medical College, Farooq Hospital, Rawalpindi*
[3]*Assistant Professor, Anaesthesia at LUMHS Jamshoro*
[4]*Senior Registrar Anaesthesia, Al Nafees Medical College and Hospital, Isra University Islamabad Campus*
[5]*Associate Professor, Gynae/OBS, HBS Medical and Dental College Islamabad*
[6]*Assistant Professor, Diagnostic Radiology, Rai Medical College and Teaching Hospital Sargodha*
Correspondence to: Shazma Ejaz, Email: shazma93@yahoo.com

ABSTRACT

Background: Gynecologic surgeries with high risks are recommended to be linked with a long operating time and exposure to general anesthesia, which can negatively influence the outcomes during the perioperative period. There is a need to have strategies that are able to improve the level of precision and efficiency of surgery at no additional expense. Intraoperative ultrasound can offer real-time view of anatomy in the pelvic region and could lead to a decrease in the complexity and exposure to anesthetics.

Objective: To determine the extent of intraoperative ultrasound in reducing the duration of operations and anesthetic exposure during high-risk gynecologic operations.

Methods: This is a prospective comparative observational study that lasted six months in a tertiary care teaching hospital. One hundred and twenty women who were subjected to high-risk hysterectomy and laparoscopy surgery under general anesthesia were recruited and split into two equal groups. Group A was operated under the aid of intraoperative ultrasound and Group B was operated under the aid of intraoperative ultrasound. The two groups had the same standard surgical and anesthetic procedures. The total anesthesia time was the primary outcome, whereas the secondary outcomes were operative time and intraoperative anesthetic stability.

Results: The two groups had demographic and clinical similarities in terms of baseline demographics and clinical characteristics. There was a significant difference in the mean operative time and total anesthesia time between intraoperative ultrasound and non-ultrasound groups. The number of patients who took extra anesthetic supplementation and intraoperative hemodynamic instability was less in the ultrasound-assisted group. There were no further expenses or complexities of using ultrasound.

Conclusion: Intraoperative ultrasound is a useful and effective supplement to high-risk gynecologic surgeries, which has led to the lessening of the operating time and the exposure of anesthesia. Its regular implementation in some cases can enhance the efficiency of the peri-operative and safety of anesthetic care without raising the expenses of health care.

Keywords: Intraoperative ultrasound; Gynecologic surgery; High-risk surgery; Anesthetic exposure.

INTRODUCTION

Surgical and perioperative treatment has made great progress in the field of gynecologic surgery, but against all odds, high-risk gynecologic surgeries still exert considerable obstacles to the anesthetic management. These issues are especially acute in patients who may have a high level of comorbidity, extensive pelvic pathology, distorted anatomy, or past surgical history, where long operating time and a high level of exposure to anesthetic procedures may negatively impact perioperative morbidity and outcome[1]. The reduction of the anesthetic period without sacrificing the quality of surgery has since become a major objective in the contemporary gynecologic practice.

Long term and short-term complications of general anesthesia include hemodynamic instability, delayed recovery, postoperative nausea and vomiting, respiratory complications, and an increased risk of cognitive dysfunction, particularly in vulnerable patients groups[2]. Even small decrements in the length of anesthesia could bring significant changes in postoperative conditions, decreased hospitalizations, and lowering the expenses of health care in high-risk surgical candidates[3]. As a result, interventions that contribute to the efficiency of surgery and the timeliness of intraoperative decisions are becoming increasingly popular.

Intraoperative imaging modalities have come up as useful supplementary factors in complex surgical procedures. Intraoperative ultrasound is one of them, which provides real-time images of the pelvic structures, allowing a surgical practitioner to precisely localize lesions, demarcate tissue boundaries, and locate vital structures in surgery[4]. In contrast to preoperative imaging, intraoperative ultrasound offers dynamic, real-time feedback with the capability to change to accommodate intraoperative observations and, thus, minimize uncertainty and the American Red Cross unnecessary surgical exploration.

Intraoperative ultrasound has gained more and more applications in gynecologic surgery in the treatment of uterine fibroids, adnexal masses, endometriosis, and pelvic adhesions in cases where anatomy may be distorted or the view may be obscured[5]. It can be used to make surgical dissection more targeted, minimize the maneuvers of trial and error, and minimize intraoperative complications like excessive bleeding or unintended damage to other organs. These benefits are particularly applicable in high risk cases where the operative and anesthetic times tend to be long due to the complexity of the surgery.

Anesthetically, shorter and more predictable periods of operation can create better intraoperative anesthetic planning and reduce the risk of anesthetic to re-emerge. Less time in the operation room, results in less cumulative dose of anesthetic agents, less time on long-term mechanical ventilation, and reduced postoperative pain management[6]. Intraoperative ultrasound with its ability to increase the precision of the surgery may play an indirect role in these anesthetic advantages though this connection has not been investigated on a large scale in gynecologic surgery.

The available literature has paid numerous attentions on the diagnostic and surgical benefits of intraoperative ultrasound but few attentions are paid on how it can be used to optimize anesthetic exposure[7]. The majority of the existing research deals with such outcomes as surgical completeness, blood loss, or the rate of complication, but the implication on the part of anesthesia is underresearched. This is a significant knowledge gap in evidence especially in the resource constrained environment, where minimization of operative duration and perioperative risk is paramount.

Also due to late presentation of high-risk cases of gynecology in developing countries at an advanced disease, new cost effective equipment like intraoperative ultrasound may be of

Received on 15-08-2023
Accepted on 09-10-2023

huge importance in enhancing surgical and anesthetic results[8]. It is portable, does not emit ionizing radiation, and its cost is not very expensive, which makes it a desirable choice to implement intraoperative monitoring widely.

In light of this, it is timely and relevant to the practice to assess the relevance of intraoperative ultrasound in reducing the amount of anesthetic exposure in high-risk gynecologic surgeries.

Objective: To determine the impact of intraoperative ultrasound in terms of shortening the length of operation and decreasing the exposure to anesthetics in high-risk gynaecologic operations.

MATERIALS AND METHODS

Study Design: This was done in the form of a prospective comparative observational study that aimed at determining the importance of intraoperative ultrasound in reducing the exposure to anesthetics during high-risk gynecologic surgeries. The chosen study design enabled the practical use in the context of the usual hospital environment without involves the expensive laboratory tests or sophisticated methods of interventions.

Study Setting: This research was conducted in the Department of Gynaecology and obstetrics, and the Department of Anaesthesia and Diagnostic Radiology, Akhtar Saeed Medical College and Farooq Hospital, Rawalpindi, Pakistan. All the surgical operations were conducted in standard operating theaters that had basic anesthesia monitoring facilities and portable ultrasound machines which were regularly available at the institution.

Study Duration: The research took place in the period of six months between April 2023 and September 2023.

Study Population: The population of study comprised of female patients who were scheduled to have high-risk gynecologic surgeries under general anesthesia. The definition of high-risk status was determined through the presence of one or more factors such as prior pelvic surgery, an expectation of distorted pelvic anatomy, the presence of large pelvic masses, a severe case of endometriosis, obesity, or other medical comorbidities to include high blood pressure or diabetes mellitus.

Sample Size: The study comprised 120 patients. The size of the sample was determined based on the common statistical assumptions with a confidence level of 95% and power of 80, where the anticipated decrease in operative and anesthetic time was at least 15 percent in the surgeries where intraoperative ultrasound was used. The patients were split into two equal groups of 60 to enable any meaningful comparison and still be attained within the available resources.

Sampling Technique: The sampling method applied was a non-probability consecutive sampling method. Patients fulfilling the inclusion criteria within the study period were all recruited until a desired sample size was reached.

Inclusion Criteria: The research study included women between the ages of 18 and 65 years who were undergoing elective or semi-elective high-risk gynecologic surgery under general anesthesia. The patients who served as informed written consent enrolled only.

Exclusion Criteria: Patients who were subjected to low-risk routine gynecologic surgeries, those who are in emergency cases, underwent surgery under regional anesthesia only and those who had contraindications to the use of ultrasound were eliminated. Incomplete perioperative records also did not undergo final analysis of patients.

Group Allocation: Two groups of patients were selected. Group A comprised patients where the intraoperative ultrasound was administered as a supplement in the operation room. Group B comprised of the patients who received similar procedures but did not receive intraoperative ultrasound. It depended on the presence of ultrasound and trained radiologist during the surgery.

Anesthetic Technique and Surgery: All the surgeries were carried by qualified gynecologists using the normal procedure of surgery. Group A: Intraoperative ultrasound was performed intra-abdominally or transvaginally, depending on the location of pathology, to localize pathology, direct the dissection and ensure that the procedure is complete. No further invasive and expensive measures were used. The anesthetic care of the two groups was subject to the usual departmental standards of anesthetic care with the anesthetic agents that are readily available, which provided uniformity and economical practice.

Data Collection: Structured proforma was used to collect data. Patient demographics, nature of surgical procedure, total hours that the operation took, total hours that anesthesia took, and intraoperative requirements of anesthetic agents were some of the variables recorded. Primary endpoint was anesthetic exposure as measured by total anesthesia time and secondary endpoint that was the requirement of long intraoperative anesthetic maintenance.

Outcome Measures: The first outcome measure was total anesthesia time. The secondary outcome measures were the operative time and intraoperative anesthetic stability, which was measured by the necessity of further anesthetic supplementation.

Data Analysis: Standard statistical software was used in entering and analyzing the data. Quantitative variables were represented in terms of mean and standard deviation whereas qualitative variables were represented in terms of frequencies and percentages. Intergroup comparison was done with suitable tests of statistics and a p-value of below 0.05 was taken to be statistically significant.

Ethical Considerations: The study was started after the institutional ethical review committee gave her ethical approval. The informed consent was taken of all participants. Confidentiality of the patients was highly ensured and patients were not charged any extra cost in the course of the study.

RESULTS

A final analysis involved 120 patients who were undergoing high risk gynecologic surgeries. The two groups were evenly divided by the research (Group A -60, as a result of the application of intraoperative ultrasound with the active participation of the gynecology, anesthesia, and radiology teams), and Group B (n = 60), as a result of the surgery without intraoperative ultrasound. Everything was done successfully without the necessity to spend a lot of money on investigations and high-tech assistance.

Group A and B were comparable in terms of mean age of patients and both groups among others exhibited similarity in terms of body mass index, parity and related medical comorbidities. This homogeneity meant that the baseline patient traits were well balanced and could not be very likely to confound the result comparison. A majority of the patients were aged between 31 and 50 years which indicated the popular age bracket of complicated gynecologic pathology.

Group A showed a considerable reduction in the operating time in contrast to Group B. Surgery with the aid of intraoperative ultrasound showed a more accurate pathological localization and clearer demarcation of tissue boundaries, which caused a smoother course of surgery and less delay during surgery. The efficiency of the procedures was also increased with the multidisciplinary interaction of anesthesia, gynecology and radiology.

time period of anesthesia was also much lesser in Group A. Shorter time period of operations directly equated to less contact with anesthetics, and the induction-to-emergence periods were smoother. The ultrasound-assisted group had fewer cases of prolonged maintenance anesthesia and less need of supplement of intraoperative anesthetics.

Anesthetic Anesthetic Intraoperative stability was improved in Group A and fewer cases of hemodynamic variation necessitating intervention. The enhanced predictability of surgical procedures enabled the anesthesiologists to optimize the level of anesthetic depth and plan the emergence. Radiology input during surgery enhanced real-time decision-making, minimizing unnecessary surgical manipulation and prolonged anesthesia.

Overall, the findings demonstrated that the use of intraoperative ultrasound, supported by close collaboration between gynecology, anesthesia, and radiology departments, was associated with reduced operative duration and minimized anesthetic exposure without increasing cost or complexity of care.

Table 1: Baseline Demographic and Clinical Characteristics of Patients

Variable	Group A (With IOUS) n=60	Group B (Without IOUS) n=60
Mean age (years)	42.6 ± 8.9	43.1 ± 9.2
Mean BMI (kg/m²)	28.4 ± 3.6	27.9 ± 3.8
Parity ≥ 2	38 (63.3%)	40 (66.7%)
Previous pelvic surgery	29 (48.3%)	31 (51.7%)
Medical comorbidities	34 (56.7%)	36 (60.0%)

Table 2: Distribution of Surgical Procedures

Type of Surgery	Group A n (%)	Group B n (%)
Abdominal hysterectomy	22 (36.7%)	24 (40.0%)
Myomectomy	16 (26.7%)	14 (23.3%)
Ovarian mass excision	12 (20.0%)	13 (21.7%)
Surgery for severe endometriosis	10 (16.6%)	9 (15.0%)

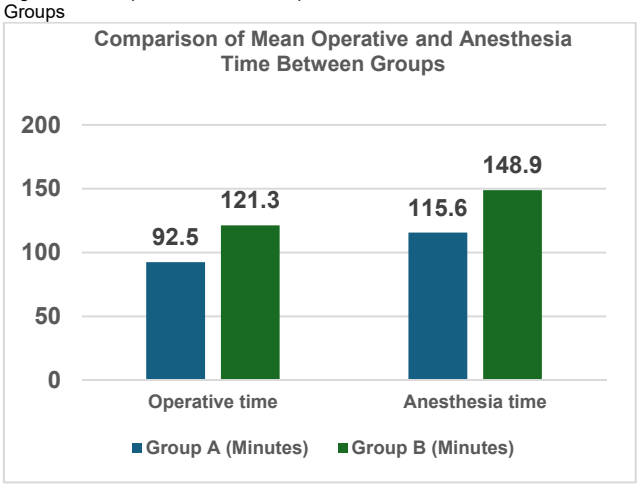
Table 3: Operative and Anesthetic Time Comparison

Parameter	Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
Operative time (minutes)	92.5 ± 18.4	121.3 ± 22.6	<0.001
Total anesthesia time (minutes)	115.6 ± 20.1	148.9 ± 24.8	<0.001

Table 4: Intraoperative Anesthetic Outcomes

Outcome Measure	Group A n (%)	Group B n (%)
Need for additional anesthetic supplementation	9 (15.0%)	21 (35.0%)
Hemodynamic instability episodes	7 (11.7%)	18 (30.0%)
Delayed emergence from anesthesia	5 (8.3%)	16 (26.7%)

Figure 1: Comparison of Mean Operative and Anesthesia Time Between Groups



DISCUSSION

The results of the current research indicated that intraoperative ultrasound application in cases of high-risk gynecologic surgeries was related to a significant decrease in the number of operative time and total anesthetic time. These findings confirm the increased awareness of the use of real-time intraoperative imaging as a feasible intervention to enhance the efficiency of the surgery and perioperative safety during intricate gynecologic operations[9]. Intraoperative ultrasound enhanced the confidence of surgical procedures by allowing the visualization of the anatomy of the pelvis in real time and minimizing confusion and indecision in the facial expression.

Sustained operative period is a vital predictor of augmented anesthetic and intraoperative danger. An increased duration of general anesthesia has been associated with increased hemodynamic instability, prolonged recovery, post operative nausea and vomiting and respiratory complications, especially in patients with major comorbidities[10,11]. The key finding of the present study is that anesthesia time in the ultrasound-assisted group was significantly reduced and thus indicates the indirect benefit of anesthesia on the accuracy of the surgical procedure.

The decreasing duration of operation as experienced in this paper is in line with the previously known benefits of using intraoperative ultrasound in gynaecologic operation. Research has also referred to that ultrasound guidance enhances the localization of uterine fibroids, adnexal masses, and deeply infiltrating disease and reduces the amount of unnecessary tissue manipulation and explorations[12,13]. This is particularly applicable in high-risk operations, in which distorted anatomy can greatly extend operating time and exposes anesthetic time.

It was found that enhanced predictability of the surgical progression under the anesthetic perspective was an important factor in enhancing intraoperative management. The patients in intraoperative ultrasound group had less instances of supplementary anesthetics and showed better intraoperative stability in this study. The given results are consistent with the current evidence that indicates that the shorter and less turbulent surgical operation enables anesthesiologists to maintain the optimal anesthetic depth with a minimum of variability[14,15].

The later emergence following anesthesia was less common in the ultrasound assisted group. Delayed recovery can be multifactorial in nature, however, with accumulative dose and length of anesthetic agent having a significant influence on delayed recovery[16]. Intraoperative ultrasound can help reduce the overall anesthesia time, which subsequently leads to the acceleration of emergence, enhanced early postoperative recovery and decreased the necessity to have postoperative monitoring.

A key strength of the study was the involvement of the multidisciplinary team comprised of gynecology, anesthesia, and radiology teams. Decision making during intraoperative procedures and reduction of the delays in procedures was improved by proper communication and real-time radiologic input. Past studies have highlighted the fact that intraoperative imaging is most beneficial when used in a well orchestrated team effort as opposed to applying it as a solitary technical supplement[17].

The pragmatic feasibility of the findings is specifically applicable in places whereby there is a weakness on the availability of sophisticated surgical technologies. Intraoperative ultrasound is an inexpensive, ubiquitous modality that does not utilize expensive consumables and infrastructure. It is useful as it can enhance the efficiency of the operations without raising the cost of the procedure making it a useful tool to be used regularly in the selected high-risk gynecologic surgeries[18].

Despite the fact that the majority of published literature has been based on surgical outcomes like completeness of excision or incidence of complications, the current study provides valuable evidence on the issue of anesthetic implications. This study expands the range of benefits of intraoperative ultrasound by showing a decrease in anesthetic exposure and the enhanced

intraoperative stability, which can improve the overall perioperative care[19].

In general, the findings of the present study indicate that intraoperative ultrasound is not merely a surgical tool, but also a good practice that can reduce the anesthetic exposure during high-risk gynaecologic surgeries. Its systematic implementation in adequately chosen cases can result in increased efficiency during perioperative setting, patient safety, and multidisciplinary care of surgical patients[20].

Limitations: This research was limited in some ways. The selection bias could have been caused by the non-randomized nature and access to ultrasound. The measurement of anesthetic exposure was mainly done in terms of anesthesia time and not in terms of close measurements of anesthetic drugs concentrations. Long-term cost-analysis and postoperative were excluded. It is suggested that future randomized, multicenter, and larger sample studies should be conducted to further confirm these results and determine long-term clinical and economic advantages.

CONCLUSION

Intraoperative ultrasound in high-risk gynecologic surgical operations was also found to have reduced operative time and total anesthetic time which led to enhanced intraoperative efficiency and anesthetic stability. Intraoperative ultrasound enabled real-time visualization of complicated anatomy of the pelvic area which resulted in accurate surgical decision making, less tissue manipulation and predictable anesthetic control. These advantages were further augmented by the multidisciplinary cooperation between gynecology, anesthesia, and radiology departments that did not raise the cost and complexity of the procedures. Implementation of intraoperative ultrasound as a standard practice on selected high-risk gynecologic cases could be an effective, possible and safe approach to maximize perioperative and minimize the risks associated with anesthesia.

REFERENCES

1. Grewal K, Timmerman D, Testa AC. The use of intra-operative ultrasound in gynecological surgery: a narrative review on indications and effectiveness. Future Sci OA. 2021;7(3):FSOA-2020-0172. doi:10.2144/fsoa-2020-0172. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7849933/
2. Moro F, Uccella S, Testa AC, Scambia G, Fagotti A. Intraoperative ultrasound-guided excision of cardiophrenic lymph nodes in an advanced ovarian cancer patient. Int J Gynecol Cancer. 2018;28(9):1672–1675. doi:10.1097/IGC.0000000000001363. Available from: https://pubmed.ncbi.nlm.nih.gov/30371564/
3. Patel HH, Banerjee D, Goldrath K, Chang J, Tandel M, Kwan L, et al. Intraoperative laparoscopic ultrasound increases fibroid detection during laparoscopic myomectomy. JSLS. 2022;26(3):e2022.00038. doi:10.4293/JSLS.2022.00038. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9439285/
4. Hao Y, Li SJ, Zheng P, Wu X, Sheng J, Yuan DL, et al. Intraoperative ultrasound-assisted enucleation of residual fibroids following laparoscopic myomectomy. Clin Chim Acta. 2019;495:652–655. doi:10.1016/j.cca.2018.05.024. Available from: https://pubmed.ncbi.nlm.nih.gov/29763581/
5. Moruzzi MC, Moro F, Bolomini G, Macchi C, Cavaliere AF, Fagotti A, et al. Intraoperative ultrasound assistance during myomectomy in a pregnant woman. Ultrasound Obstet Gynecol. 2020;55(6):840–841. doi:10.1002/uog.21881. Available from: https://pubmed.ncbi.nlm.nih.gov/31587408/
6. Nelson G, Bakkum-Gamez J, Kalogera E, Glaser G, Altman A, Meyer LA, et al.; ERAS® Society. Guidelines for perioperative care in gynecologic/oncology surgery: Enhanced Recovery After Surgery (ERAS) Society recommendations — 2019 update. Int J Gynecol Cancer. 2019;29(4):651–668. doi:10.1136/ijgc-2019-000356. Available from: https://pubmed.ncbi.nlm.nih.gov/30877144/
7. Cascella M, Bimonte S, Di Napoli R. Delayed emergence from anesthesia: what we know and how we act. Local Reg Anesth. 2020;13:195–206. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7652217/
8. Hsieh A, Baker MB, Phalen JM, Mejias-Garcia J, Hsieh A, Hsieh A, Canelli R. Handheld point-of-care ultrasound: safety considerations for creating guidelines. Journal of Intensive Care Medicine. 2022 Sep;37(9):1146-51;. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9393648/
9. Dixon L, Lim A, Grech-Sollars M, Nandi D, Camp S. Intraoperative ultrasound in brain tumor surgery: A review and implementation guide. Neurosurgical Review. 2022 Aug;45(4):2503-15. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9349149/
10. Adler AC, Chandrakantan A, Conlin FT. Perioperative point of care ultrasound in pediatric anesthesiology: a case series highlighting real-time intraoperative diagnosis and alteration of management augmenting physical examination. J Anesth. 2019 Jun;33(3):435-440. doi: 10.1007/s00540-019-02654-0. Epub 2019 May 10. PMID: 31076947.
11. Moharir A, Tobias JD. The role of a handheld ultrasound device to facilitate remote learning for a point-of-care ultrasound certificate program. Adv Med Educ Pract. 2021;12:1029–1036. doi:10.2147/AMEP.S328625. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8462468/
12. Di Mitri M, Thomas E, Di Carmine A, et al. Intraoperative ultrasound in minimally invasive laparoscopic and robotic pediatric surgery: our experiences and literature review. Children (Basel). 2023;10(7):1153. doi:10.3390/children10071153. Available from: https://www.mdpi.com/2227-9067/10/7/1153
13. Smallwood N, Dachsel M. Point-of-care ultrasound (POCUS): unnecessary gadgetry or evidence-based medicine? Clin Med (Lond). 2018;18(3):219–224. doi:10.7861/clinmedicine.18-3-219. Available from: https://www.rcpjournals.org/content/clinmedicine/18/3/219
14. Baribeau Y, Sharkey A, Chaudhary O, Krumm S, Fatima H, Mahmood F, Matyal R. Handheld point-of-care ultrasound probes: the new generation of POCUS. Journal of cardiothoracic and vascular anesthesia. 2020 Nov 1;34(11):3139-45.
15. Zhang X, Li Y, Wang J. Effect of ultrasound image-guided nerve block on perioperative anesthetic requirements and recovery: a randomized clinical trial. Evid Based Complement Alternat Med. 2022;2022:4428883. doi:10.1155/2022/4428883. Available from: https://www.hindawi.com/journals/ecam/2022/4428883/
16. Patel H, Banerjee D, Goldrath K, Chang J, Tandel MD, Kwan L, Yu S. (Repeat note: practical prospective cohort on IOLUS in myomectomy showing detection/operative-time tradeoffs.) JSLS. 2022;26(3):e2022.00038. doi:10.4293/JSLS.2022.00038. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9439285/
17. Hao Y, Li SJ, Zheng P, Wu X, Sheng J, Yuan DL, Zhou Q, Wei W, Duan AH, Wu QQ, Lu D. Intraoperative ultrasound-assisted enucleation of residual fibroids following laparoscopic myomectomy. Clinica Chimica Acta. 2019 Aug 1;495:652-5.
18. Levine EM, Fernandez CM. The Expanding Role of Sonography in the Clinical Practice of Modern Obstetrics and Gynecology: A Clinical Perspective. Journal of Diagnostic Medical Sonography. 2023 May;39(3):303-7. Available from: https://journals.sagepub.com/doi/full/10.1177/87564793231153641
19. Pino MA, Imperato A, Musca I, et al. New hope in brain glioma surgery: the role of intraoperative ultrasound — a review. Brain Sci. 2018;8(11):102. doi:10.3390/brainsci8110102. Available from: https://www.mdpi.com/2076-3425/8/11/102
20. Li L, Yong RJ, Kaye AD, Urman RD. Perioperative point of care ultrasound (POCUS) for anesthesiologists: an overview. Current pain and headache reports. 2020 May;24(5):20.

This article may be cited as: Cheema NN, Ejaz S, Shaikh M, Fatima S, Naheed S, Baig T; Role of Intraoperative Ultrasound in Minimizing Anaesthetic Exposure during High-Risk Gynecologic Surgeries. Pak J Med Health Sci, 2023;18(11): 605-608.