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Factors associated with hospital length of stay in patients with thoracic hydatid cyst disease undergoing surgical intervention: a retrospective study

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Abstract

Background Hydatid cyst (HC) frequently affects the lungs, making it the second most common site after the liver. This study evaluated the clinical characteristics, surgical procedures, complications, laboratory findings, and factors influencing hospital length of stay (LOS) in patients undergoing surgery for pulmonary hydatid cysts.

Methods This retrospective observational study included adult patients who underwent surgery for lung HC between 2017 and 2021. Data were collected using a standardized checklist covering demographics, medical history, clinical symptoms, laboratory findings, treatment details, surgical characteristics, and risk factors. The primary outcome was LOS, defined as the duration between surgery and discharge.

Results A retrospective analysis of 214 patients with pulmonary hydatid cysts revealed a male predominance (59.3%; median age, 36 years). The most common symptom was cough (39.3%), followed by chest pain and dyspnea. Right lower lobe involvement (51.4%) and synchronous liver cysts (13.6%) were frequently observed. Elevated erythrocyte sedimentation rate (ESR), eosinophilia, positive serology, prolonged air leak, and fever were correlated with longer LOS. The dominant surgical procedure was cystotomy with capitonnage (95.8%), performed via thoracotomy.

Conclusions Most hydatid cysts were located in the right lower lobe, with cough being the most frequent presenting symptom. Thoracotomy and cystotomy with capitonnage were the primary surgical procedures performed. Common postoperative complications included wound infection, empyema, and prolonged air leak. Awareness of factors such as elevated ESR, eosinophilia, positive serology, prolonged air leak, and fever may improve management and reduce hospital LOS.

Keywords Echinococcosis surgery, Thoracic, Postoperative complications, Length of stay, Risk factors

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Introduction

Echinococcosis, or hydatid disease, is caused by *Echinococcus granulosus*. It is a major health problem throughout the world, especially in agricultural and livestock areas. The global incidence rates range from 1 to 200 cases per 100,000 persons per year. The endemic regions include the Mediterranean basin, Latin America, the Middle East, China, and Africa [1, 2]. In Iran, which is an endemic country for the disease, its incidence has been estimated at about 0.61 annually per 100,000 [3, 4]. Despite efforts undertaken for disease control programs, echinococcosis is still widespread and is being considered an important public health problem in developing countries [5].

Hydatid cysts (HC) primarily affect the liver (50–70%) and lungs (20–40%), with the latter more common in younger patients [6, 7]. Pulmonary cysts may remain asymptomatic for many years and more often are located in the right lower lobe [6, 8]. Symptomatic cases typically result from cyst rupture or compression of adjacent structures, leading to cough, chest pain, dyspnea, and, in rare cases, hydatoptysis [6, 8, 9]. Complications such as empyema, pneumothorax, and prolonged air leaks are particularly common with ruptured cysts and contribute to prolonged hospital stays [10, 11].

Diagnosis relies on imaging and serological tests, though serological sensitivity is limited in pulmonary cases compared to hepatic involvement [12]. Imaging features such as the “water lily” sign in ruptured cysts are helpful diagnostic indicators [10]. Elevated ESR and eosinophilia are also observed in patients with ruptured or infected cysts, reflecting the underlying inflammatory response [13].

Management strategies for hydatid cysts depend on size, location, and rupture status. Surgical intervention remains the gold standard, especially for ruptured or complicated cysts. Techniques such as cystotomy-capitonnage, wedge resection, and lobectomy are employed based on cyst characteristics, with cystotomy-capitonnage preferred for lung preservation [1, 6]. Preoperative albendazole therapy helps reduce the risk of recurrence by sterilizing cysts [1]. Surgery for pulmonary hydatid cysts generally yields favorable outcomes, with postoperative complications occurring in up to 20% of cases and a mortality rate ranging from 0 to 2%, primarily influenced by cyst size, complexity, and surgical approach [6].

This study aims to evaluate factors influencing hospital length of stay (LOS) in patients undergoing surgery for pulmonary hydatid cysts at a tertiary care center in Iran. By identifying clinical, laboratory, and surgical predictors of prolonged hospitalization, this research contributes to improving patient outcomes and optimizing resource utilization.

Materials and methods

Study protocol

This retrospective observational study reviewed surgeries for pulmonary hydatid cysts performed at Imam Khomeini Hospital, Tehran, Iran, from 2017 to 2021 (IR.TUMS.IKHC.REC.1401.283). Adult patients who had surgery for lung hydatid cysts during this period were included in the study. Diagnosis involved imaging, clinical presentation, and serological tests, while treatment response was assessed using clinical and radiological findings.

Patients with bilateral lung hydatid cysts requiring staged thoracotomy were excluded from the study. Bilateral cases were defined as those with cysts present in both lungs, as opposed to multilobar involvement, which refers to multiple cysts confined to different lobes on the same side of the lung. The number of patients excluded due to missing data and those who needed staged thoracotomy was 15.

Data collection

Data were collected using a standardized checklist that included demographics (age, sex, and place of residence), medical history (target organ, number of cysts, clinical symptoms, anaphylactic reaction and smoking status), laboratory findings (serology, peripheral blood eosinophilia and ESR), treatment details (albendazole regimen), surgical characteristics (cyst complications, surgery type, cyst size and location, and reoperation), and risk factors (contact with dogs). For cyst location, cases with multiple cysts affecting different lobes of the same lung were classified as ‘multilobar involvement.’ In contrast, cysts present in both lungs were categorized as bilateral pulmonary hydatidosis and excluded from the study.

Outcomes and definitions

This study aimed to identify factors influencing the hospital LOS following surgery for lung hydatid cysts. The primary outcome was LOS, which was categorized as short (5–7 days), intermediate (8–11 days), or prolonged (12–14 days). The LOS was considered from the day of surgery to the date of discharge. Potential influencing factors included demographics (age, gender, residence, smoking status), preoperative symptoms, albendazole use, cyst location, cyst size (< 10 cm or > 10 cm), presence of extrapulmonary involvement (liver), surgical approach, serological test results (ELISA method), laboratory findings (ESR adjusted for age, eosinophil count > 500/μL) and postoperative complications.

Secondary outcomes included surgical complications such as prolonged air leak (lasting more than 5 days), empyema, reoperation, wound infection, and mortality.

Statistical analysis

Descriptive statistics and data distribution

The Kolmogorov-Smirnov test assessed continuous variable distribution. Descriptive statistics employed medians for continuous variables and frequency tables for categorical variables. Frequency diagrams were used to visualize the categorical variables distribution. The Chi-square test was used to assess associations between categorical variables.

Comparison of continuous variables between groups

Due to non-normal data distribution, non-parametric tests were used to compare continuous variables between groups. The Mann-Whitney U test was employed for comparison between two groups, while the Kruskal-Wallis test was used for comparisons between multiple

Table 1 Baseline characteristics of the patients

Parameter		Number	Frequency (%)
Age (Year)	< 20	18	8.4%
	21–40	126	58.9%
	41–60	57	26.6%
	> 61	13	6.1%
Gender	Female	87	40.7%
	Male	127	59.3%
Residence	Rural	74	34.6%
	Urban	140	65.4%
Direct exposure to dogs		54	25.2%
Smoking		90	42.1%
Liver hydatid disease		29	13.6%
Involved lobes	RLL	110	51.4%
	LLL	37	17.3%
	RUL	15	7.0%
	LUL	16	7.5%
	More than one Lobe on the same side	36	16.8%
Cyst size	< 10 cm	170	79.4%
	> 10 cm	44	20.6%
ESR	high	33	15.4%
	normal	187	84.6%
Eosinophilia		34	15.9%
Positive Serology		36	16.8%
Albendazole regimen		30	14.0%
Cough		84	39%
Chest pain		62	29%
Dyspnea		38	16.9%
Hemoptysis		11	5.1%
Fever		32	15%
Hydatoptysis		7	3.3%
Anaphylactic reaction		0	0
Abdominal pain		9	4.2%
Nausea/Vomiting		6	2.8%

RLL: Right Lower Lobe, LLL: Left Lower Lobe, RUL: Right Upper Lobe, LUL: Left Upper Lobe

groups. Post-hoc analysis with Bonferroni correction was conducted for significant differences in Kruskal-Wallis tests. Effect sizes were determined using r values for Mann-Whitney U tests and eta-squared values for Kruskal-Wallis tests.

Predictors of length of hospital stay (LOS)

An ordinary regression model was used to predict LOS based on demographic, clinical, surgical, and laboratory factors. Model assumptions were checked and standardized beta coefficients with 95% confidence intervals (CIs) were reported for the final model's predictor variables.

Results

Patient disposition and characteristics

A total of 229 patients with lung hydatid cysts underwent surgery at Imam Khomeini Hospital between 2017 and 2021. Out of these, 214 patients (127 males, 87 females) with a median age of 36 (Interquartile=31–45) years met the inclusion criteria and were enrolled in the study. Most patients (126) were aged 20–40 years. About 65.4% lived in urban areas and 42.1% had a history of smoking. A history of direct contact with dogs was reported in 54 patients (25.2%). 14% of patients had previously used albendazole (Table 1).

Clinical symptoms

The most common symptoms were cough (39.3%), chest pain (29.0%), and dyspnea (16.9%). Other symptoms included fever, hemoptysis, abdominal pain, hydatoptysis, and nausea/vomiting. No cases of anaphylactic reactions were reported. (Table 1).

Surgery type

All patients underwent open thoracotomy surgery through a posterolateral incision at the fifth intercostal space. Thoracotomy was the preferred approach due to the limited availability of Video-assisted thoracoscopic surgery (VATS) for hydatid cysts in our region. The most common surgical procedure was cystotomy with capitonnage (95.8%), followed by lobectomy (2.8%) and wedge resection (1.4%). Transthoracophrenotomy was performed in 13.6% of patients to address both lung and liver hydatid cysts simultaneously (Table 2).

Cyst location, size, characteristics

Most cysts were located in the lower lobes, with the right lower lobe being the most frequent site. Multilobar involvement was observed in 16.8% of cases, while synchronous liver involvement occurred in 13.6%. A majority of cysts were intact (73.8%), and smaller cysts (<10 cm) were more common (79.4%) than larger ones (Table 1).

Table 2 Hospital length of stay according to all variables

Variable	Number	Median of hospital stay (IQR)	Mean Rank	P- value	
Age (Year)	<20	18	5 (5–6)	70.89	$P=0.021^{**}$
	21–40	126	6 (5–8)	112.98	
	41–60	57	6 (5–9)	111.28	
	>61	13	5 (5–6)	88.54	
Gender	male	127	6 (5–8)	106.56	$P=0.776^*$
	female	87	6 (5–8)	108.88	
Residence	rural	74	6 (5–8)	104.43	$P=0.577^*$
	urban	140	6 (5–8)	109.13	
Direct exposure to dogs	54	6 (5–8)	108.23	$P=0.916^*$	
Smoking	90	5 (5–7.25)	97.75	$P=0.038^*$	
Prior use of albendazole	30	10 (5–11)	155.35	$P=0.000^*$	
Liver hydatid disease involved lobes	29	9 (6.50–10)	138.76	$P=0.000^*$	
Involved lobes	RLL	110	6 (5–8)	109.91	$P=0.004^{**}$
	LLL	37	5 (5–6)	85.51	
	RUL	15	5 (5–6)	151.37	
	LUL	16	5 (5–5.75)	89.88	
	More than one lobe on the same side	36	6 (5–9)	112.29	
Surgery type	Cystostomy and capitonnage	205	6 (5–8)	105.19	$P=0.00^{**}$
	lobectomy	6	10.50(9.75–11.75)	199.50	
	Wedge resection	3	5 (5–6)	81.33	
Cyst size	< 10 cm	170	5 (5–7)	93.67	$P=0.000^*$
	> 10 cm	44	9 (7–10)	160.92	
Complicated cyst	perforated	56	9 (7–10)	185.01	$P=0.000^*$
	Non perforated	158	5 (5–6)	89.60	
ESR	High	33	10 (9–11)	190.41	$P=0.000^*$
	Normal	181	5 (5–6)	92.38	
Eosinophilia	34	5 (5–7.25)	190.12	$P=0.000^*$	
Positive serology	36	9 (7–9)	157.07	$P=0.000^*$	
Chest pain	62	6.5 (5–9)	123.87	$P=0.009^*$	
Cough	84	6 (5–8)	109.17	$P=0.737^*$	
Hydatoptysis	7	11 (10–12)	201.93	$P=0.000^*$	
dyspnea	36	7 (5–10)	99.04	$P=0.369^*$	
Hemoptysis	11	10 (9–11)	195.14	$P=0.000^*$	
Fever	32	9 (7–11)	167.38	$P=0.000^*$	
Abdominal pain	9	9 (9–10)	119.67	$P=0.307^*$	
Nausea/Vomiting	6	6 (5.75–7)	119.67	$P=0.606^*$	
Reoperation	1	7 (7–7)	145.00	$P=0.521^*$	
Wound infection	33	7 (5–8)	127.29	$P=0.035^*$	
Empyema	21	9 (8–11)	178.69	$P=0.000^*$	
Air leak	19	10 (10–12)	188.00	$P=0.000^*$	

*Mann Whitney U test was used to compare LOS between two groups

**Kruskal-Wallis test was used to compare LOS between more than two groups

Table 3 Complication rate of surgeries

Parameter	Number	Frequency (%)
Air leak	19	8.95
Empyema	21	9.8%
Reoperation	1	0.5%
Wound infection	33	15.4%
Mortality	-	-

Outcomes

Surgical complications and mortality

Postoperative complications included wound infection (15.4%), empyema (9.8%), and prolonged air leak (>5 days) (8.95%). Reoperation was rare (0.05%), and there were no deaths. Complications were successfully managed during hospitalization. While complications specific to hydatid cyst surgery, such as bronchial fistulas, and general thoracic surgery complications, such as atelectasis, pneumonia, respiratory distress, and postoperative bleeding, are clinically relevant, our data collection was limited to the complications listed in Table 3. Therefore, the analysis of complications in this study focuses solely on wound infection, empyema, prolonged air leak, and reoperation rates. A 33-year-old patient with empyema required reoperation on the third postoperative day due to purulent discharge. The thoracic cavity was washed, and a new capitonnage was performed. No further complications were reported during the 3-month follow-up. Larger cyst size was significantly associated with prolonged air leak and empyema, but not with reoperation or wound infection (Table 3).

Hospital length of stay

Analysis of hospital LOS revealed that patients aged 21–40 and 41–60 years had longer median stays compared to other age groups ($p=0.021$). Additionally, factors such as preoperative albendazole use ($p<0.001$), smoking history ($p=0.038$), the presence of liver hydatid cysts ($p<0.001$), larger cysts (> 10 cm) ($p<0.001$), specific cyst location ($p=0.004$), complicated cyst presentations (perforated cysts) ($p<0.001$), and lobectomy surgery ($p<0.001$) were linked to prolonged LOS. Postoperative complications, including wound infection ($p=0.035$), empyema ($p<0.001$), and prolonged air leak (>5 days) ($p<0.001$), also impacted LOS. An ordinal regression model further identified elevated ESR ($p=0.004$), eosinophilia ($p=0.004$), positive serology ($p=0.030$), prolonged air leak (>5 days) ($p=0.020$), and fever ($p=0.003$) as independent predictors of prolonged hospitalization (Table 4).

Discussion

Despite the global decline in prevalence, HC disease remains a major public health problem, especially in rural areas and underdeveloped countries [5, 14].

Table 4 Results of ordinal regression model used to determine predictors of LOS

Variable	Estimate	Wald	P value	95% Confidence interval	
				Lower bound	Upper bound
ESR	4.843	8.075	0.004	1.509	8.183
Eosinophilia	5.558	8.331	0.004	1.784	9.333
Serology	2.233	4.730	0.030	0.221	4.245
Air leak	3.659	5.432	0.02	0.582	6.737
Fever	2.811	8.862	0.003	0.960	4.661

LOS=Hospital length of stay

LOS was categorized as short (5–7 days), intermediate (8–11 days), or prolonged (12–14 days). An ordinary regression model was used to examine factors predicting LOS

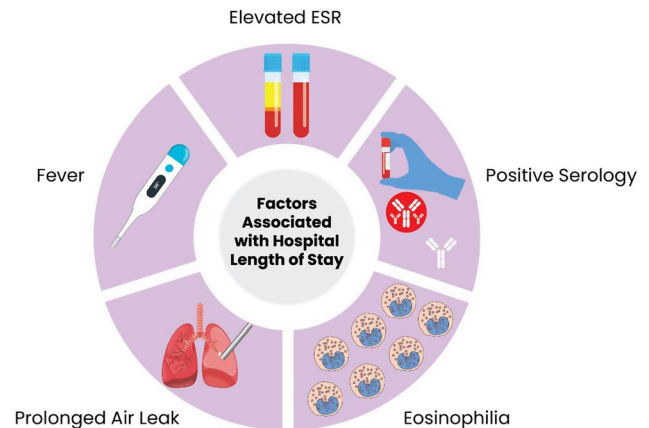
Surgical intervention is the definitive treatment for pulmonary HC, regardless of cyst size or complexity, as even simple cysts can lead to severe complications if untreated [15]. A 2023 study reported an average LOS of 12.25 and 12.58 days for lung-preserving surgery and lung resection, respectively [8], highlighting the potential burden of postoperative recovery. This study aimed to evaluate clinical, diagnostic, and surgical factors influencing hospital LOS in patients undergoing pulmonary HC surgery. Key findings are compared with similar studies to provide broader clinical context and practical implications for improving patient care.

Clinical symptoms

Cough (39.3%) was the most common symptom in this study, followed by chest pain (29.0%), dyspnea (16.9%), and fever (15.0%), consistent with the literature identifying these as key features of pulmonary hydatid cysts [2, 8, 16, 17]. The absence of anaphylactic reactions highlights effective perioperative management.

Ruptured vs. intact cysts

Ruptured and intact cysts have distinct clinical and surgical implications. In this study, empyema, a common complication of ruptured cysts, was correlated with prolonged LOS. Rupture results in antigenic exposure, triggering inflammatory responses and secondary infections such as empyema or bronchial fistulas [10, 11, 18]. Conversely, intact cysts, particularly large or multilobar cysts, increase surgical complexity and may prolong recovery times due to technical challenges during surgery [1, 19–21]. Differentiating between ruptured and intact cysts is critical for tailoring preoperative and postoperative management. Future research should evaluate whether early intervention in patients with predictive factors for rupture, can reduce complications and LOS.

**Fig. 1** Factors associated with prolonged hospital length of stay (LOS) in patients with pulmonary hydatid cysts

Factors influencing hospital length of stay

This study identified elevated ESR, eosinophilia, positive serology, persistent air leak, and fever as independent factors linked to prolonged LOS (Fig. 1).

Elevated ESR, a marker of systemic inflammation, was significantly correlated with prolonged LOS in our study ($p=0.004$). This aligns with prior research linking elevated ESR to complicated hydatid disease, such as ruptured or infected cysts, which often necessitate extended recovery and monitoring [22, 23]. Studies have also suggested that elevated ESR, particularly when combined with eosinophilia, may indicate an increased risk of complications, including multiple-organ involvement and cyst rupture [21]. For instance, a 2020 study reported a 16% higher prevalence of postoperative complications in patients with abnormal ESR ($p=0.014$) [23]. These findings suggest that elevated ESR may reflect a heightened inflammatory burden, especially in severe or complicated cases, and highlight its potential role in predicting prolonged hospitalization.

Eosinophilia is a marker of parasitic infection, occurring in less than 15% of hydatid disease cases [6, 21]. However, it is more frequently observed in patients with larger cysts (>7 cm), active or transitional WHO stages, and complicated disease presentations ($p=0.042$, $p=0.001$, $P<0.001$) [1, 19]. It is often triggered by the release of antigenic cyst fluid due to rupture, leading to a Th2 immune response [19, 20]. In this study, the association between eosinophilia and prolonged LOS suggests that eosinophilia may serve as a marker of disease severity, indicating the need for extended care in these patients.

Positive serology was another significant predictor of prolonged LOS. Serological markers reflect active cyst stages or recent antigenic exposure, which are often correlated with more complex or advanced disease [18, 24]. Patients with positive serological findings may require

additional monitoring or interventions, contributing to longer hospitalization.

Postoperative complication rates in various studies range from 3.5 to 7.5% [25]. Persistent air leak, a known complication of thoracic surgeries, was correlated with prolonged LOS ($p=0.02$). This finding is expected, as air leak delays chest tube removal and discharge. In hydatid cyst surgeries, incomplete closure of the bronchial openings may cause air leak especially in large or complicated cysts [26]. This highlights the importance of meticulous surgical techniques to minimize drainage time.

Fever, a nonspecific but common finding, was also significantly correlated with prolonged LOS. In hydatid disease, fever often signals secondary infection, rupture-related inflammation, or other complications such as empyema [2, 22, 27]. Consistent with prior researches, this study suggest that fever may serve as a marker of disease severity, necessitating further management and extended hospitalization.

Preoperative albendazole use and synchronous liver hydatid cysts were also linked to prolonged LOS. Albendazole is often used to sterilize cysts and reduce intraoperative spillage risks, but its use may indicate more advanced or complex cases requiring extended postoperative care [15, 17]. Similarly, synchronous liver involvement increases surgical complexity and morbidity, contributing to longer hospitalization. These findings align with prior studies showing higher complication rates in patients with multi-organ involvement [21].

Cyst distribution in the lung

The predominance of HCs in the right lower lobe (51.4%) observed in our study aligns with previous reports [2, 3, 8, 16, 28]. This distribution may be attributed to anatomical factors, including the larger lung volume in the lower lobes and the preferential blood flow and ventilation to these regions. Additionally, the proximity of the right lower lobe to the liver may facilitate hematogenous dissemination of *Echinococcus granulosus* larvae. Understanding this predilection can aid in early detection and targeted intervention.

Surgical complications and mortality

The use of thoracotomy as the primary surgical approach in our cohort may have contributed to prolonged LOS compared to minimally invasive techniques. Thoracotomy is correlated with greater postoperative pain, longer drainage times, and delayed recovery compared to VATS, as shown in prior studies [29]. However, the lack of access to minimally invasive techniques in our region necessitates reliance on thoracotomy. This underscores the importance of resource allocation and training to incorporate advanced techniques that could reduce hospital stay and improve patient outcomes in the future.

The complication rates observed in our study, including wound infection (15.4%), empyema (9.8%), and prolonged air leaks (8.95%), were higher than those reported in the literature. Previous studies have reported lower complication rates, typically ranging from 3.5 to 7.5%, with atelectasis, empyema, and air leaks being the most common postoperative issues [2, 3, 16, 25, 30]. These findings emphasize the importance of optimizing surgical techniques and postoperative care to minimize complications and improve recovery times.

Conclusion

This study highlights several factors correlated with prolonged hospital stay in patients undergoing pulmonary hydatid cyst surgery, including elevated ESR, eosinophilia, positive serology, persistent air leak, fever, preoperative albendazole use, and synchronous liver involvement. Differentiating between ruptured and intact cysts can guide management strategies to reduce LOS and improve outcomes. Expanding access to minimally invasive techniques, where feasible, may further enhance recovery times and patient care.

Strengths and limitations

This study has several limitations. Its retrospective design and reliance on data from a single center limit the generalizability of the findings. Incomplete medical records restricted the assessment of certain complications, such as atelectasis, respiratory distress, and postoperative bleeding. Additionally, the time between diagnosis and surgical intervention, which could influence outcomes, was not evaluated. Delayed intervention may allow cysts to grow or rupture, increasing surgical complexity and the risk of complications, ultimately prolonging LOS. Exploring this relationship in future research could provide valuable insights into the benefits of timely surgical management. Despite these limitations, the study provides important insights into the clinical characteristics and factors correlated with prolonged LOS in HC patients. Future multicenter studies with comprehensive data collection are necessary to validate these findings, identify additional predictors of prolonged hospitalization, and assess the potential of minimally invasive surgical techniques in reducing LOS and improving patient outcomes.

Author contributions

R.E: contributed in Project administration, Validation, and revising original draft; M.S: contributed in Project administration, Investigation and Validation. G.R: contributed in Writing Original Draft; N.K: contributed in writing and revising the original draft; S.S: contributed in Investigation, revising and editing the draft; H.A: contributed in project administration, Validation, Writing and revising original draft.

Funding

We did not receive any fund or any financial support for this study.

Data availability

No datasets were generated or analysed during the current study.

Declarations**Ethical approval**

Investigations were in accordance with the Helsinki Declaration of 1964 and all subsequent revisions. The study protocol was reviewed and approved by the Institutional Review Board of Imam Khomeini Hospital (IR.TUMS.IKHC.REC.1401.283).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 19 July 2024 / Accepted: 25 December 2024

Published online: 07 January 2025

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