

ARTICLE INFORMATION

Received: January, 21, 2025

Revised: March, 22, 2025

Available online: March, 23, 2025

at : <https://e-jurnal.iphorr.com/index.php/minh>

The risk of malignancy index (RMI) in diagnosis of ovarian malignancy: A case report

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Abstract

Background: Ovarian cancer is among the deadliest gynecological cancers, with nearly 70% of cases identified at an advanced stage. It is the fourth most common cause of cancer-related deaths in women. While early detection significantly improves ovarian cancer outcomes, the disease often presents no symptoms in its early stages, resulting in delayed diagnosis and worsened prognosis. Achieving an accurate initial diagnosis in women with ovarian cancer is essential for ensuring early, correct treatment and reducing the risk of overtreatment. Clinically, various methods are available to assess ovarian malignancy risk, including the Risk of Malignancy Index (RMI).

Purpose: To demonstrate the use of the RMI score to differentiate between benign and malignant ovarian tumors.

Method: The case of Mrs. LKS, a 34-year-old woman who had experienced abdominal distension and related symptoms for one year, was analyzed in detail. The patient underwent multiple diagnostic evaluations, including a physical exam, ultrasound, abdominal CT scan, and histopathological analysis. The RMI, a well-established malignancy risk assessment tool, was employed. The initial evaluation of ovarian malignancy risk primarily considered ultrasound results, menopausal status, and serum CA-125 levels, with an RMI score above 200 indicating a high risk of ovarian cancer. Surgical procedures performed included a total hysterectomy, omentectomy, appendectomy, and ascitic fluid drainage.

Results: The patient's main issue was a gradually worsening abdominal distension over the past year, accompanied by lower abdominal pain, nausea, and significant weight loss. Physical examination and imaging revealed a heterogeneous cystic mass in the abdomen, suggesting a malignant ovarian cyst, along with the presence of ascites. The RMI score exceeded 200, indicating a high risk of ovarian malignancy. The patient underwent a laparotomy, which included a total hysterectomy, omentectomy, and appendectomy, leading to a postoperative diagnosis of stage III B ovarian cancer. Despite the intervention, the prognosis remained poor (*dubia ad malam*) due to the advanced stage at diagnosis.

Conclusion: The RMI calculation serves as a valuable and reliable method for guiding diagnostic, management, and treatment decisions for patients with benign and malignant ovarian masses.

Keyword: Advanced-stage; Ovarian Cancer; Risk of Malignancy Index.

INTRODUCTION

Ovarian tumors are among the most frequent reasons for visits to gynecology clinics (Harris, Whittemore, Itnyre, & Collaborative Ovarian Cancer Group, 1992; Sundar, Neal, & Kehoe, 2015). However, early detection of ovarian tumors remains challenging due to the wide range of symptoms and

signs experienced by patients. Treatment decisions for ovarian tumors are heavily influenced by whether the tumor is benign or malignant (Burbos, N., & Duncan, 2010; Rooth, 2013). Tumor characteristics such as size, mobility, consistency, shape, possible fluid content, and pain level provide clinicians with

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valuable indicators for assessing suspected ovarian tumors (Zhang, Yu, Hou, Li, Ning, Wu, & Sun, 2019). The classification system for ovarian tumors was first introduced by Taylor in 1929 and later formalized by the International Federation of Gynecology and Obstetrics (FIGO) in 1971 and by the World Health Organization (WHO) in 1973. Six types of ovarian tumors have been identified (Geomini, Kruitwagen, Bremer, Cnossen, & Mol, 2009). One of the challenges in selecting appropriate therapy for ovarian tumors is the lack of reliable preoperative diagnostic markers and economic constraints, particularly in developing countries.

Recommended diagnostic procedures for classifying ovarian tumors include transvaginal ultrasound, MRI, CT, serum CA125 and CA199 levels, and biopsy, though definitive diagnosis can still be difficult in some cases (Tingulstad, Hagen, Skjeldestad, Onsrud, Kiserud, Halvorsen, & Nustad, 1996; Lodha, 2016; Liberto, Chen, Shih, Wang, Wang, & Pisanic, 2022; Rout, Midha, Mukherjee, & Bhaumik, 2024). Accurate early diagnosis helps

reduce the need for gynecological referrals. The Risk of Malignancy Index (RMI), introduced by Jacobs et al. in 1955, originally combined ultrasound findings, serum CA125 level, and menstrual status in a multiplicative formula (Jacobs, 1991; Majmudar, & Abdel-Rahman, 2008). In 2009, Yamamoto et al. proposed an updated RMI formula (RMI 1, 2, and 3), which incorporated ultrasound findings, CA125 levels, and menopausal status (Yamamoto, Yamada, Oguri, Maeda, & Fukaya, 2009). RMI is widely accepted as a straightforward method, as it relies on ultrasound scores, menopausal status, and serum CA125 levels. Four RMI versions currently exist (RMI I, II, III, IV). The ultrasound characteristics (U) used in RMI assessment include multilocular cystic lesions, solid areas, bilateral lesions, ascites, and intra-abdominal metastasis. Tumor size (T) is measured via ultrasound, while menopausal status (M) is defined by age over 50 and at least one year of amenorrhea. Serum CA125 levels are assessed in the laboratory. The RMI calculation is illustrated in Figure 1 (Geomini et al., 2009; Tingulstad et al., 1996).

Table 1 Schematic presentation of four different RMI score algorithms

Variants	Ultrasound Score (U) ^a	Menopausal Score (M)	Tumor Size (S), cm ^b
RMI I = $U \times M \times \text{CA-125}$	U = 0 (0 parameter)	M = 1 (premenopausal)	Not applicable
	U = 1 (1 parameter)	M = 3 (postmenopausal)	
	U = 3 (≥ 2 parameters)		
RMI II = $U \times M \times \text{CA-125}$	U = 1 (0 or 1 parameter)	M = 1 (pre-menopausal)	Not applicable
	U = 4 (≥ 2 parameters)	M = 4 (postmenopausal)	
RMI III = $U \times M \times \text{CA-125}$	U = 1 (0 or 1 parameter)	M = 1 (premenopausal)	Not applicable
	U = 3 (≥ 2 parameters)	M = 3 (postmenopausal)	
RMI IV = $U \times M \times S \times \text{CA-125}$	U = 1 (0 or 1 parameter)	M = 1 (premenopausal)	S = 1 (<7)
	U = 4 (≥ 2 parameters)	M = 4 (postmenopausal)	S = 2 (≥ 7)

^aParameters: presence of a multilocular cystic lesion, solid areas, a bilateral lesion, ascites, and intra-abdominal metastasis

^bSingle greatest diameter

Figure 1. Schematic presentation of four different RMI score algorithms

RESEARCH METHOD

This study presents a case report of a patient who underwent detailed evaluation for her symptoms. The process began with gathering general information, taking a medical history, performing a physical examination, and conducting further investigations, including blood tests, an electrocardiogram, chest X-

ray, computed tomography (CT) scan, gynecological ultrasound, and pathological analysis. The patient's diagnosis was confirmed using the Risk of Malignancy Index I (RMI I). Both surgical and conservative treatments were deemed more suitable for this case.

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DOI: <https://doi.org/10.33024/minh.v8i1.664>

RESEARCH RESULTS

A 60-year-old married housewife from Rokan Hilir reported abdominal enlargement over the past year, accompanied by lower abdominal pain, nausea, and weight loss.

From anamnesis we found that she had abdominal pain and enlargement, she did not have vaginal bleeding, history of PAS, or family history of related diseases. Her menstrual cycle was normal, and she had previously undergone two cesarean sections. On physical examination, her general appearance and vital signs were within normal limits; however, her abdomen appeared distended with normal bowel sounds and tenderness, and a palpable mass was present. A bimanual vaginal exam revealed a uterus about the size of an egg, with a mass in the upper pelvis reaching the level of the umbilicus, though the

adnexa were challenging to assess. Blood tests, an electrocardiogram, and a chest X-ray returned normal results. A CT scan indicated a heterogeneous cystic mass in the mid to lower abdomen, suggesting a malignant ovarian cyst with ascites. The preliminary diagnosis was P2A0, suspected ovarian cancer. Gynecological ultrasound showed an anteflexed uterus of normal size with a visible endometrial line, a normal right ovary, and a hypoechoic mass in the left ovary measuring 10 x 7.5 x 8 cm, featuring multilocular septations, papillary projections, and ascites (as shown in Figure 2). The patient's serum CA125 level was 70 kU/L. Her RMI I score was calculated using the formula: menopausal score x ultrasound score x CA125 concentration (kU/L), resulting in an RMI score of 210 (3 x 1 x 70).



Figure 2. Ultrasound shows a hypoechoic mass on the left ovary measuring 10x7.5x8 cm with multilocular, septa and papillae

The patient was scheduled for a surgical procedure that involved laparotomy, moderate adhesiolysis, evacuation of ascitic fluid, total hysterectomy, bilateral salpingo-oophorectomy, total omentectomy, and appendectomy. The pathology results confirmed the presence of malignancy. Postoperative care included admission to the High Care Unit (HCU) and fasting until bowel sounds returned. The patient received intravenous fluids (RL/D5% in a 2:1 ratio over 24 hours), along with Ampicillin Sulbactam 1.5 g every 8 hours, Tranexamic acid 500 mg every 8 hours, Ketorolac 30 mg every 8 hours, and Omeprazole 40 mg every 12 hours.

DISCUSSION

Diagnosing ovarian tumors remains challenging, particularly in healthcare facilities lacking the resources to accurately assess tumor characteristics. There are six main types of ovarian tumors: serous

(50-55%), mucinous (30-45%), endometrioid, clear cell, seromucinous, and Brenner tumors. Of these, 12-20% are malignant (Zhang et al., 2019; Jayson, Kohn, Kitchener, & Ledermann, 2014). Diagnosis typically involves taking a patient history, conducting a physical examination, performing additional tests, and sometimes surgical procedures to identify the type of ovarian tumor. Jacob et al. introduced a straightforward method known as the Risk of Malignancy Index (RMI), which helps differentiate benign from malignant adnexal tumors (Zhang et al., 2019).

In this study, the diagnostic process began with a detailed patient history focused on identifying risk factors, followed by a thorough physical examination and supportive tests to assess disease severity and any potential metastasis to nearby organs. The RMI was also used to determine if the ovarian tumor was benign or malignant. The RMI I formula is derived from

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multiplying menopausal status (M) by ultrasound findings (U) and serum CA125 level (Geomini, 2009; Yamamoto, 2009; Lheureux, Gourley, Vergote, & Oza, 2019; Hoffman, Schorge, Schaffer, Halvorson, Bradshaw, & Cunningham, 2012). In this case, the patient's age of 60 suggested a high risk for ovarian cancer, likely due to increased mutation and cell accumulation. Menopause, defined in this context as occurring after age 50 with at least one year of amenorrhea, is an important variable in the RMI formula. Studies indicate that after age 50, declining levels of progesterone and estrogen increase the likelihood of tumor growth, whether benign or malignant. For individuals over 50, a score of 3 is assigned (Huwidi, Abobregre, Assidi, Buhmeida, & Ermiah, 2022).

During a bimanual vaginal examination, the uterus was felt to be about the size of an egg, with a mass in the upper pelvis reaching the level of the umbilicus, while the adnexa was difficult to assess. A CT scan revealed a heterogeneous cystic mass in the middle and lower abdomen, suggesting a malignant ovarian cyst with ascites. Gynecological ultrasound showed a normal-sized, anteverted uterus with a visible endometrial line, a normal right ovary, and a hypoechoic mass in the left ovary measuring 10 x 7.5 x 8 cm with multilocular compartments, septations, and papillary projections. These physical exam findings align with other studies indicating characteristics of ovarian malignancy, such as dense areas, multilocularity, papillae, and irregular septa. The ultrasound score (U) for this case was 1, assigning a score of 1 based on these parameters. Ultrasound is known to be sensitive in detecting early-stage ovarian cancer, making it valuable in malignancy risk assessment to help reduce patient morbidity. While the sensitivity of ultrasound is 100%, its specificity is lower at 69.8% (Hoffman et al., 2012; Patel, 2006; Rein, Gupta, Dada, Safi, Michener, & Agarwal, 2011).

The patient's serum CA125 level was 70 IU/mL. Previous research shows a significant increase in serum CA125 levels in postmenopausal women. The normal concentration for serum CA125 is below 35 IU/mL, and if this threshold is exceeded, further abdominal and pelvic ultrasound is warranted. In women under 40 with suspected ovarian cancer, additional markers like alpha-fetoprotein (AFP) and beta-human chorionic gonadotropin (beta-hCG)

should be checked along with CA125 to confirm epithelial ovarian cancer (National Institute for Health and Care Excellence, 2023). The sensitivity of CA125 in the RMI I formula is 54%, considered the most effective predictor for distinguishing benign from borderline tumors (Alanbay, Akturk, Coksuer, Ercan, Karaşahin, Dede, & Baser, 2012). The RMI I score is calculated by multiplying these three factors, with scores interpreted as follows: an RMI I score below 60 suggests a benign tumor, a score of 60-200 indicates a borderline ovarian tumor, and a score above 200 signals malignancy (Zhang et al., 2019). In this case, the RMI I score was 210, indicating ovarian malignancy. An RMI score over 200 reflects a high risk of ovarian malignancy, with RMI I and RMI III sensitivities at 74% and 80% and specificities at 89% and 92%, respectively, both with positive predictive values around 80%.

CONCLUSION

Diagnosing ovarian cancer remains challenging, especially when facilities and infrastructure are limited. One commonly used diagnostic method is the Risk of Malignancy Index I (RMI I), which calculates the risk based on menopausal status, ultrasound findings, and serum CA125 levels. When clinical symptoms align and the RMI I score is over 200, this suggests a diagnosis of ovarian cancer.

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DOI: <https://doi.org/10.33024/minh.v8i1.664>

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