Oncology and Radiotherapy ©
Vol.17 Iss.12: 905-911 • REVIEW ARTICLE

The Characteristic Role of Imaging in Management of Endometrial Cancer: A Review Article

Zeinab Safarpour Lima[1], Ladan Younesi[1], Hediyeh Jalayeri[2], Mohammad Hadi Akbarizadeh Mashkani[3], Ayda Roostaee[1]

[1] Department of Radiology, School of Medicine, Iran University of Medical Sciences (IUMS), Tehran, Iran

[2] MD, Iran University of Medical Sciences, Tehran, Iran

[3] Radiologist, School of Medicine, Iran University of Medical Sciences (IUMS), Tehran, Iran

Abstract

Endometrial cancer, also known as uterine cancer, starts from the uterus and affects the layer of cells that form endometrium of the uterus. It is the most common gynecologic cancer in women worldwide. Diagnosis of endometrial cancer depends on many factors including tumor cells histological grade, the presence of lymph node metastases, depth of central layer of uterine cervix invasion and uterine wall invasion, and the age of patient. Endometrial cancer usually causes abnormal vaginal bleeding, prompting women to visit their physicians and as a result, mostly detected at early stages. Removing of the uterus through surgery in early stages can treats endometrial cancer most of the times. Conducting a biopsy would be required if heterogeneity or endometrial thickening is confirmed to make a precise histopathological recognition. Due to the fact that within 80% of cancers are anticipated at early stages, the overall diagnosis is favorable. Endometrial cancers even those with locally advanced malignancies confined to the pelvis often responds to surgical resection. However, cervical cancer is an exception. Imaging before surgery can help to establish better treatment planning. Several imaging techniques have been developed and used as medical diagnostic tools, including magnetic resonance imaging (MRI), vaginal ultrasonography (VUS), and positron-emission tomography (PET). In this review, the role of imaging in detection, recognition and diagnosis of recurrence in patients with endometrial cancer is highlighted. Moreover, a summary of recent imaging techniques with desirable performance in endometrial cancer care is presented.

Key Words: Endometrial cancer, imaging technique, vaginal ultrasonography, computed tomography, PET, MRI.

Address for correspondence
Ayda Roostaee, Department of Radiology, School of Medicine, Iran University of Medical Sciences (IUMS), Tehran, Iran, Email: Ayda152001@yahoo.com

Word count: 5242 **Tables:** 03 **Figures:** 07 **References:** 49

Received:-28 October, 2023, Manuscript No. OAR-23-123089
Editor assigned:- 01 November, 2023, Pre-QC No. OAR-23-123089 (PQ)
Reviewed:- 08 November, 2023, QC No. OAR-23-123089 (Q)
Revised:- 21 November, 2023, Manuscript No. OAR-23-123089 (R)
Published:- 29 November, 2023, Invoice No. J-123089

INTRODUCTION

Endometrial cancer is the most prevalent gynaecological cancer worldwide. Due to rising fatness and enhancing longevity in poor countries, the number of cases with endometrial cancer is rising among people of these countries. There are five cancers that engage the reproductive system of women: vulval cancer, ovarian cancer, cervical cancer, vaginal cancer, and endometrial cancer that also called womb or uterine cancer [1,2]. These five cancers are referred to as gynaecological cancer. Endometrial cancer could be fully treated at the primary stages. To this end, the stage of cancer needs to be determined. Although, endometrial cancer frequently responds to surgery, but proper application of treatment and optimization of treatment planning depends on detailed mapping of the cancer spread and determination of disease extent particularly extr-auterine spread prior to surgery [3].

In most cases, this disease is diagnosed at early stages when tumors spread within 75% of uterine corpus. After primary surgery, about 15 to 20 % of tumors reoccur in the vagina/pelvis (almost one third) or at other places (almost two thirds) [4]. In their annual report about the outcomes of gynecological cancer therapy, Creasman et al., [5] reported that about 80% of the patients underwent endometrial cancer surgery, survived. From the other side, they revealed that, patient's awareness of their cancer regardless the stage of disease cause the reduction of patients hope from being treated. According to Pecorelli and Revised [6], the aim of introducing the formal imaging techniques, such as magnetic resonance imaging (MRI), transvaginal

ultrasound (TVU), positron emission tomography (PET) and computed tomography (CT) is to enhance risk classification and to adjust primary surgical procedure with systemic remedy algorithm. Although, utilizing these imaging techniques could lead to more information on tumor staging, but they have not been good enough to replace surgical staging at many surgical institutes [7-10]. Application of conventional and functional imaging techniques made it possible to use imaging biomarkers in endometrial cancer prior to surgery. It causes better risk classification for each treatment method. Advancement of novel functional imaging techniques plays a fundamental role in developing new imaging biomarkers, allows better risk categorization before operation in endometrial cancer. Thus, in this study, a review of conventional and new imaging techniques as well as a description of the practical application of imaging in staging, diagnostic estimation, treatment planning and their reported staging performance is presented.

Endometrial cancer epidemiology

Endometrial cancer is a malignancy that is very common in women all over the world and its prevalence is rising annually. ♀Determining the epidemiology of this disease could assist in treatment as well as development of new prevention approaches. According to Siegel et al., [11] study, within 75% of endometrial cancers are diagnosed at early stages. In the United States, among 52,630 women diagnosed to have endometrial cancer, the average age of diagnosis were 60 years. Ferlay et al., [12] in their study about cancer incidence and mortality, found that endometrial cancer is the 5th common malignancy among women in the world. Furthermore, they reported that, the prevalence of endometrial cancer is more common in developed countries and considered one of the most common causes of death of women there. According to Epstein and Blomqvist [13] who studied imaging in endometrial cancer, some factors resulted in rising the prevalence of endometrial cancers in developed countries are: obesity, diabetes, tamoxifen therapy and lynch syndrome [14]. The most common symptoms of endometrial cancer are abnormal uterine bleeding and vaginal discharge. Patients with advanced ovarian cancer may indicate abdominal tympanites, abdominal pain, bladder function or changing of bowel. With regard to cancer prevalence statistics [15], novel imaging technologies allows early diagnosis of endometrial cancers in more than 80% of the cases. This makes overall diagnosis promising.

Pathology of endometrial cancer

Pathologic factors including lymphovascular invasion and tumor histology are considered as major factors in diagnosis of endometrial cancer. Radiologists uses other prognostic factors such as cervical involvement, depth of myometrial invasion and locoregional spread [16,17]. Histologically, two type of endometrial cancers can be distinguished: type I and II. Accounts for 90% of the tumors, endometrioid adenocarcinoma is the most common type I that is associated with obesity and extra estrogen. The incidence of these usually low graded tumors is in the early postmenopausal period. They could be accurately diagnosed and treated by hysterectomy [18]. Type II of endometrial cancers includes uterine carcinosarcomas and clear-cell, serous papillary subtypes. There is no extra estrogen or abnormal hyperplasia in type II cancers. Frequently occurred in elderly woman, these type of the cancer are categorized as high-grade tumors and has poor diagnosis [19]. Similar to distant cancers, these type of tumors tend to spread to distant parts of body and invade the myometrium and lymphovascular spaces.

Risk factors of endometrial cancer

Several researchers have referred to the main risk factors that could increase the possibility of endometrial cancers. Renehan [20] asserted that type I of endometrial cancers occur mainly after long time exposing to estrogen. Due to the reducing estrogen levels of the body during menopause, hormone replacement therapy would be needed. The risk of endometrial cancer increases about 20 times after performing hormone replacement therapy. Sjögren et al., [21], in the other hand, conducted a study on the risk factors of endometrial cancer and hormone replacement therapy and argued that, the risk of endometrial cancer significantly magnifies, if progestins used regularly or occasionally. In their study about uterine cancer tumors, Kurman et al., [22] revised the WHO classification of tumors in

reproductive organs. According to their classification, endometrial cancers are divided in two main groups of precancers and epithelial tumors. Various sections of this classification from clinicopathologic view are presented in table 1.

Tab.1. Descriptive statistics of the included patients.

Precancers	atypical ductal hyperplasia/ carcinoma of endometrium mild dysplasia neoplasia
	endometrial hyperplasia without atypia
Endometrial cancer	Endometrioid carcinoma
	Squamous differentiation
	Villoglandular papillary carcinoma
	Secretory; Porosome-mediated cell secretion
Neuroendocrine tumors (NETs)	Low-grade neuroendocrine tumor
	High-grade neuroendocrine carcinoma

Renehan et al., [20] performed a meta-analysis about the relationship between body-mass index and incidence of cancer and concluded that, there are a positive relationship between rising of estrogen production in fat tissues of obese women and the incidence of endometrial cancer. In another research on the relationship between insulin resistance, adiponectin, and endometrial cancer, Soliman PT, et al., [23] found that, fatness affects diabetes that in turn, could elevate the risk of endometrial cancer. Soliman, et al., [24] studied the influence of premenopausal age on endometrial cancer amid woman and reported that, an important factor with the potential to increase the risk of endometrial cancer is age. They also stated that, progressive endometrial cancer may lead to fatness and nulliparous among young women. In their research on endometrial cancers, Iglesias et al., [25] classified the typical risk factors of endometrial cancer and specified their relative risks, as presented in Table 2.

Tab.2. Risk factors of endometrial cancer

Risk factor	Relative risk
Unopposed estrogen therapy	10–20
Estrogen-generating tumors	>5
Tamoxifen	2.5–7
Fatness	2–5
Menstrual factors	1.5–3
Diabetes mellitus	2–3
Nulliparity/infertility	2–3

Staging of endometrial cancer

Staging is an essential step in decision-making on choosing optimal treatment method. The staging is determined through examining removed tissue during cancer operation, as a result, it sometimes called surgical staging. When surgery is not possible, based on the results of biopsy, physical examination and imaging done before surgery, the cancer may rather be given a clinical stage. Established in 1958 and revised in 2009, FIGO staging system is an inclusive method of staging endometrial cancers (Table 3) [26].

Tab.3. FIGO staging system for endometrial cancer.

Stage	Description
IA	Tumor limited to uterus, <50% myometrial invasion
IB	Tumor limited to uterus, ≥50% myometrial invasion
II	Cervical stromal invasion
IIIA	Tumor invasion into serosa or adnexa
IIIB	Vaginal or parametrial involvement
IIIC1	Pelvis node involvement
IIIC2	Paraaortic node involvement
IVA	Tumor invasion into bladder or bowel mucosa
IVB	Distant metastases or inguinal lymph node involvement

The development of cancer in space and tissue of body could be detected using FIGO surgical staging system. But to detect cancer development more accurately, cross-sectional imaging technique is usually applied to assist in pre-surgical evaluation and determination of the optimal type of therapy. Preoperative usage of current advanced imaging technologies has brought some advantages including, ability to determine the gross cervical invasion, analyzing the absolute depth of myometrial invasion, and identifying suspicious lymph nodes to be sampled, so that patients may undergo hormone therapy or radiation therapy that are examples of induction therapy [27,28]. As a result, imaging plays a significant role in analyzing and staging of these patients.

Imaging Techniques

In their study, Epstein and Blomqvist [29] investigated the imaging role in evaluation the local disease extension and concluded that, Ultrasound and MRI are two powerful techniques to evaluate the extent of local disease. They further stated that, imaging techniques of CT and PET are frequently used to detect lymph nodes or distant metastases. As Kinkel et al., [30] stated, the combination technique of DWI-MRI is used to better tumor detection as well as to detect small metastatic layers in lymph nodes and gastrocolic omentum. According to some studies that reviewed the application of transvaginal ultrasound in cancer and metastatic diseases, imaging techniques such as transabdominal ultrasound, MRI, CT and PET can be used to detect extrauterine soft tissue involvement [31,32]. They also reported that, imaging techniques of ultrasound, MRI, CT, and PET/PET-CT can be used in monitoring and detecting recurrent disease. In patients with higher risk of recurrence after operation, CT/PET-CT imaging techniques could be used for detection of diseases as well as for planning accessory treatment. Finally, they stated that, imaging techniques like PET/PET-CT are frequently used in post-treatment supervision of patients with high risk of recurrence and without symptoms.

Initial Evaluation of Ultrasound

According to Papadopoulos et al., [33] who studied the ultrasound role in endometrial cancer, pelvic ultrasound is done for evaluation of suspected endometrial cancer. Ultrasound is inexpensive, fast available and also able to provide good quality images of adnexa and uterus. The key parameter in estimation of uterus sonography is endometrial thickness. Today, transvaginal ultrasound technique due to its high-quality images has superiority our transabdominal technique. According to ACOG committee [34], best imaging technique to assess patients with postmenopausal bleeding is transvaginal ultrasound (TVS). Heterogeneity and atypical endometrial thickening are major symptoms of endometrial cancer in ultrasonic technique (see Figure 1). However, these symptoms are not unique and as a result, it could be concluded that ultrasound technique is not reliable in distinguishing between various stages of cancer nor between prosperity, hyperplasia or polyps [33].

When it seems that the endometrium goes thin or thinner, after performing ultrasound examination, it's preferable to image the patient at the first stage of endometrial. Endometrial sampling in these patients should be implemented builds on a number of combined factors rather the examination of endometrial thickness. The thickening of endometrial in patients with no vaginal bleeding during postmenopausal confusion has reported to be less than 5 mm. In the other hand, some studies reported that endometrial thickness in patients with uterine bleeding is greater than women who are symptomless [35]. When endometrial cancer is developed in body, endometrial tissue get thicker and may undergo incongruous and cystic changes (see Figures 1, 2). Despite the benefits of this technique, ultrasound has also some limitations such as, its dependency to the operator, restricted field of view, and data limitation due to usage for estimation of lymphadenopathy, cervical stromal invasion and spread of tumor outside of the uterus.

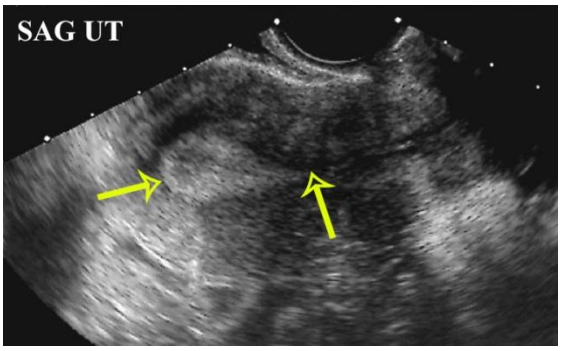

Fig.1. An ultrasound image of a 65 years old female with endometrial cancer who was evaluated because of her post-menopausal bleeding. Performing Longitudinal transvaginal scan through the uterus represents the obviously thickened and heterogeneous endometrium (shown by yellow arrows), recalls the myometrial invasion. (Derived from [36]).

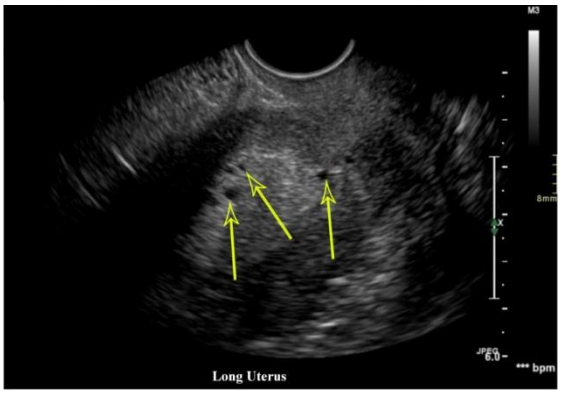

Fig.2. Transvaginal pelvic ultrasound image of the previous woman shows thickening of endometrial with cystic changes (shown by yellow arrows). Derived from [36].

Positron emission tomography–computed tomography (PET/CT)

With regards to world cancer report [37], endometrial cancer is recognized as an incongruous mass that places in the middle of uterus. Computed tomography (CT) with improved contrast is performed in the preoperative stage to determine the quality of metastatic disease in high-risk tumors. Due to the low contrast resolution of computed tomography (CT), its usage is limited in estimating myometrial invasion. It can also be used to indicate close organ invasions, nodal metastases and metastatic disease [38]. However, application of computed tomography (CT) for estimating responses as well as accurate observation during the treatment of endometrial cancer is common (see Figure 3). Vaginal bleeding may sometimes be mistaken with hematuria, leading to a prompt urologic estimation. So, endometrial pathology should be considered as a basic tool for patients undergoing hematuria imaging. Evaluation the abnormal thickening of endometrium and pelvic imaging are important goals in these patients (see Figure 4). Positron emission tomography–computed tomography (PET/CT) is a nuclear imaging technique consisted of an x-ray computed tomography scanner and a positron emission tomography scanner in order to exploit the capabilities of both techniques and to acquire successive images from both systems in the same time. PET/CT is an essential diagnostic technique that used for a wide range of objectives from initial staging to careful monitoring of response therapy in various cancers [39].

During computed tomography, the primary observed tumors are usually characterized as little hypodense than normal surrounding myometrial tissue (see Figure 5, A). Computed tomography with improved contrast has less contrast resolution in soft-tissue imaging, thus considered in lower ranking compared to MRI and TVU for local staging objectives [40,41]. Fludeoxyglucose (18F-FDG) is a radio-pharmaceutical used in medical imaging. By integration of the metabolic and morphologic characteristics of tumor, it allows for registration of functional and structural data illustrated in combined images at a same time (see Figure 5, B). According to above-mentioned constraints, and due to the spatial resolution limitations of FDG PET-CT technique, it would be desirable to replace it with MRI and TVU for estimating the cervical stromal invasion and myometrial depth in pelvic disease [42].

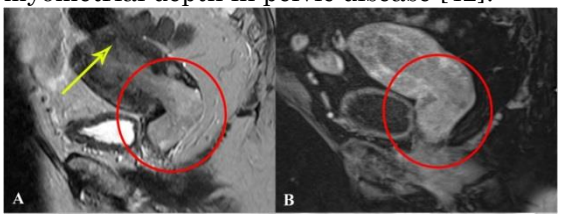

Fig.3. Computed tomographic scan of a 65 years old female with endometrial cancer. A and B; superior sagittal post-contrast images showing hypoenhancing, polypoid endometrial mass prolapsing across the cervix to the upper vagina (red circles). There seen within 50% myometrial invasion by the mass (yellow arrow). Derived from [36].

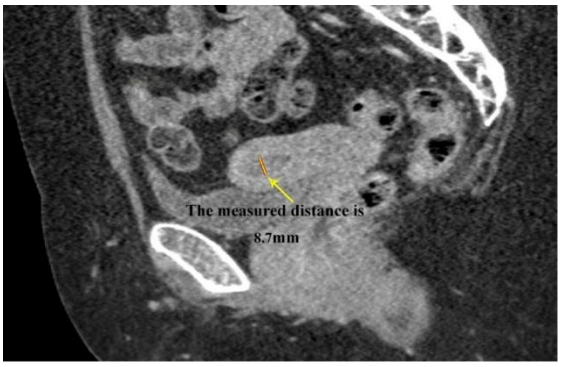

Fig.4. Sagittal CT image of a 65 years old female with hematuria. A soft heterogeneous thickening of endometrium equals to 8.7 mm is shown (arrow). Derived from [36].

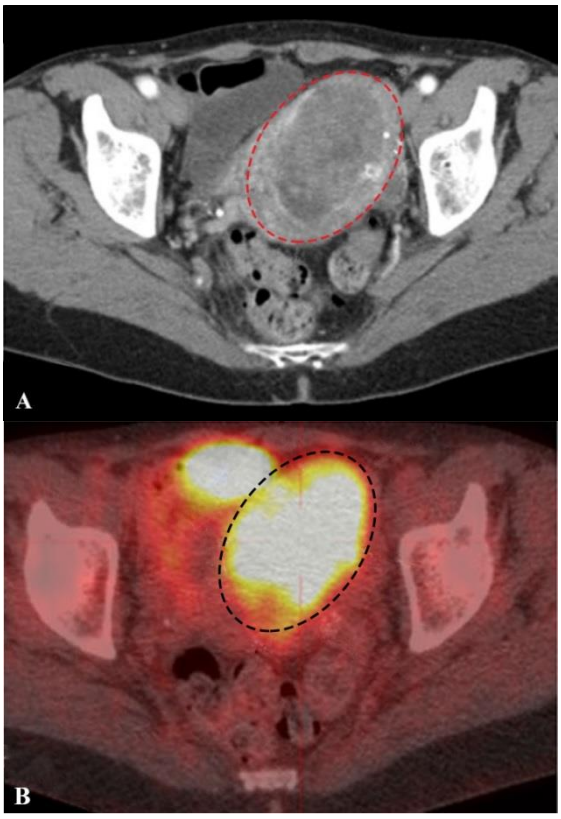

Fig.5. Distinctive quality of preoperative imaging in a 65 years old female with endometrial cancer. A: sagittal CE CT image. B:

FDG PET-CT image illustrating endometrioid grade 3 cancer (FIGO stage IB). Derived from [36].

Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) is one of the most important techniques that is used before performing a surgical operation. It is used for staging endometrial cancer of a special part of the body as well as for estimating the risk of recurrence after treatment. Based on the recommendations of European society of urogenital imaging, MRI is one of the best options for treatment planning [30]. They suggested that using MRI is preferable in the following cases: in cancers that are in advanced stages, in cancers with medium to high levels of risk, and when sampling of lymph nodes is needed. However, other studies argued that, using MRI is recommended in situations where cervical invasion is probable, or for estimating myometrial invasion in early stages of cancers, particularly following a careful examination of pelvic lymph [32,43]. The size and range of local disease and also the development of tumor exterior of the uterus can be accurately demonstrated. Enhanced contrast resolution MRI images can be used to specify local and regional development of diseases like lymphadenopathy. It also can be utilized to estimate the cervical stromal and myometrial invasion. Accordingly, MRI can be applied in a broad range of disease, classified in FIGO staging system. From one hand, abnormal lymph nodes can be detected using MRI imaging that makes preoperative planning possible, and from the other hand, MRI imaging can present additional information about the tumor volume and uterine size that is a big help for surgical approximation. As previously mentioned, MRI is the best imaging technique to diagnose and evaluate endometrial cancer. According to Cao et al., [44], T2-weighted imaging is an advanced version of MRI that used in determination of quantity effective T2. In this technique, bleeding and haemosiderin residuals translated into hypointense. Usually, endometrial cancer is emerged in T2-weighted images as an average intensity signal. The encircling myometrium is consisted of two independent layers; an outer myometrium layer that is normally a signal with intermediary intensity and variable semblance, and an inner myometrial layer that is called junctional zone which its borders are at endometrium and appears as a signal with low band (Figure 6).

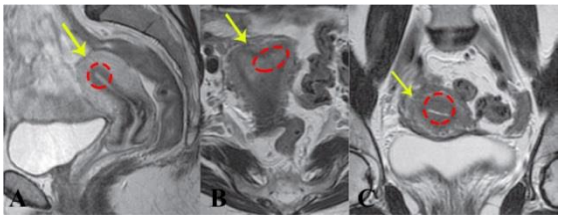

Fig.6. A T2-weighted MRI image showing the anatomy of normal zonal in various planes of (A) sagittal, (B) axial, and (C) coronal. Dotted red circles; indicate junctional zone or inner myometrium and endometrium. Yellow arrows; indicate outer myometrium. Bright sides; indicate high signal. Dark sides; indicate low signal. Derived from [36].

In their study about the local-regional staging of endometrial cancer, Manfredi et al., [45] pointed that the best method for endometrial cancer staging is using ultrasound MRI in synergy with computed tomography (CT) and clinical estimation. They reported that the accuracy of this method in staging endometrial cancer is around 90%. They further stated that MRI can assist in designing the medical algorithms that are used to proper management of patients.

Managing the obtained information

According FIGO system and obtained information through above imaging techniques, patients could be categorized in groups with low and high levels of risk. Surgery is the main option for those patients with minimally-invasive disease. Patients who their disease is identified as low risk are placed in IA stage (type I). These patients undergo surgical removing of uterus and mutual unilateral salpingo-oophorectomy without removing of one or more groups lymph nodes. Neoadjuvant therapy via radiation or chemotherapy is not performed in these patients. According to Sala et al., [46], the aim of this method is to get patient's treatment and can be done for almost all cases of endometrial cancer. Patients with high-risk disease that are grouped in IB stage or higher, not only needs to undergo surgical removal of the uterus, but also dissection of retroaortic, pelvic, preaortic, left and right lateral aortic lymph node. Application of hyperthermic intraperitoneal chemotherapy (HIPEC) and cytoreductive surgery (CRS) as effective methods for treating various cancers in their advanced stages has recognized. The

patients undergo chemotherapy or radiotherapy after surgery. Anyway, patients with advanced stages of disease may receive neoadjuvant hormone/chemotherapy in addition to surgical management [47]. In other word, patients with progressive disease that medical treatment is not beneficial for them, can receive surgical mediation such as debulking that is the process of depletion the volume of a tumor as much as possible, uterus removal via surgery to block the bleeding, and some sedative treatments.

As stated by Narayan et al., [48] in their research on patients with intermediate to high risk levels of endometrial cancer that treated with surgery and adjuvant radiotherapy, the risk of recurrence is higher in patients with lymphovascular space invasion and lymph node metastases. According to their research, the recurrence of cancer has happened in 90% of cases after 3 years from primeval surgery, within 20% of all recurrences after radiotherapy and hysterectomy in cervical cancer were only vaginal, and postoperative locoregional return of cancer has observed in about 58% [49]. Application of PET/CT techniques, presently, can facilitate the choosing of proper treatment program and prevent from occurring of asymptomatic various metastases, and as a result, treatment hardness has reduced, and successfulness rate has significantly increased. It could also be said that, MRI is advantageous particularly to picture the treatment algorithm scope and its relation with common anatomical constructions (see Figure 7).

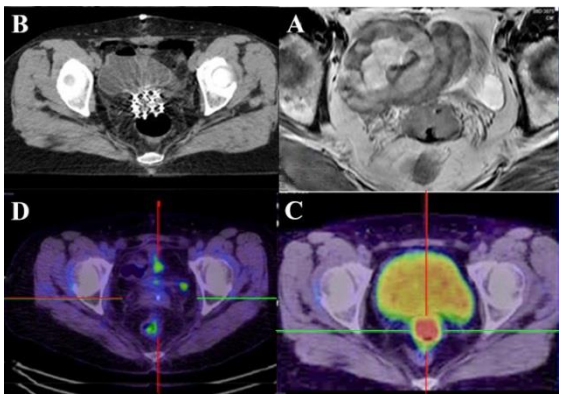

Fig.7. The usage of imaging for detection, treatment plan and revision about recurring endometrial cancer. A; axial MRI image of a vault mass of vagina that is located inside of bowel loops. B; using interstitial implant needles for radiotherapy planning computed tomography that represents a type of internal radiation therapy. C; previous radiotherapy PET-CT, performed to confirm the recurrence of cancer. D; a PET-CT implemented after 6 month of treatment.

CONCLUSION

Endometrial cancer is among the most prevalent malignancies that threaten women health worldwide. Significant role of imaging techniques in identifying endometrial cancer as well as in its nonoperative and preoperative staging is widely acknowledged. MRI is one of the most important imaging techniques that by providing substantial information for risk classification prior to treatment, can play a significant role in surgical process. Computed tomography (CT) and Positron emission tomography–computed tomography (PET/CT) are among effective imaging techniques that can provide decisive predictions about doubtful progressive disorders and in cancers with high risk level. Nowadays, application of imaging techniques in monitoring endometrial cancer has become a common matter. Accordingly, it could be said that, the use of imaging techniques has resulted in more powerful treatment algorithms, improving local region control and reducing treatment related complications. Finally, it could be concluded that, improved imaging techniques could contribute to the process of selecting the best rescue plans for patients that suffer from recurrent endometrial cancer.

REFERENCES

1. Amant F, Moerman P, Neven P, et al. Endometrial cancer. Lancet. 2005;366;491-505. Google Scholar Crossref
2. Javedani Masrour M, Shafaie A, Yoonesi L, Aerabsheibani H, Javedani Masrour S. Evaluating Endometrial Thickness and Vascular Ultrasound Pattern and Pregnancy Outcomes in Intrauterine Insemination Cycle. Asian J Pharm Res Health Care. 2016;8:24-29. Google Scholar Crossref
3. Talhouk A, McAlpine JN. New classification of endometrial cancers: The development and potential applications of genomic-based classification in research and clinical care. Gynecol Oncol Res Pract. 2016;3:14. Google Scholar Crossref
4. Salvesen HB, Haldorsen IS, Trovik J. Markers for individualized therapy in endometrial carcinoma. Lancet Oncol. 2012;13:353–361. Google Scholar Crossref
5. Creasman WT, Odicino F, Maisonneuve P. Carcinoma of the corpus uteri. FIGO 6th annual report on the results of treatment in gynecological cancer. Int J Gynaecol Obstet. 2006;95 Suppl 1:105–143. Google Scholar Crossref
6. Pecorelli S. Revised FIGO staging for carcinoma of the vulva, cervix, and endometrium. Int J Gynaecol Obstet. 2009;105:103–104. Google Scholar Crossref

7. Haldorsen IS, Gruner R, Husby JA. Dynamic contrast-enhanced MRI in endometrial carcinoma identifies patients at increased risk of recurrence. Eur Radiol. 2013;23:2916–2925. Google Scholar Crossref
8. Azarpey N. Sensitivity and specificity of ultrasound and mammography for detection of breast malignancy: A systematic review and meta-analysis. Onkol Radioter. 2023;17:333-339. Google Scholar Crossref
9. Forootan M, Tabatabaeefar M, Mosaffa N, Rahimzadeh Ashkalak H, Darvishi M. Investigating Esophageal Stent-Placement Outcomes in Patients with Inoperable Non-Cervical Esophageal Cancer. J Cancer. 2018;9:213–218. Google Scholar Crossref
10. Kitajima K, Suenaga Y, Ueno Y. Preoperative risk stratification using metabolic parameters of (18) F-FDG PET/CT in patients with endometrial cancer. Eur J Nucl Med Mol Imaging. 2015;42:1268–1275. Google Scholar Crossref
11. Siegel R, Naishadham D, Jemal A. Cancer statistics. CA Cancer J Clin. 2013;63:11–30. Google Scholar Crossref
12. Ferlay J, Soerjomataram I, Ervik M. Cancer Incidence and Mortality Worldwide: IARC CancerBase No. 11. 2015. Lyon: International Agency for Research on Cancer. Google Scholar Crossref
13. Epstein E, Blomqvist L. Imaging in endometrial cancer. Best Pract Res Clin Obstet Gynaecol. 2014;28:721–739. Google Scholar Crossref
14. Arora V, Quinn MA. Endometrial cancer. Best Pract Res Clin Obstet Gynaecol. 2012;26:311–324. Google Scholar Crossref
15. Cancer Incidence Statistics. 2015. [URL].org/health-professional/cancer-statistics/statistics-by-cancer-type/uterine-cancer. Google Scholar Crossref
16. Denschlag D, Ulrich U, Emons G. The Diagnosis and Treatment of Endometrial Cancer: Progress and Controversies. Dtsch Arztebl Int. 2011;108:571-577. Google Scholar Crossref
17. Chen L, Berek J. Endometrial carcinoma: clinical features and diagnosis. UpToDate. 2016. Google Scholar Crossref
18. Wright JD, Barrena Medel NI, Sehouli J. Contemporary management of endometrial cancer. Lancet. 2012;379:1352–1360. Google Scholar Crossref
19. Tirumani SH, Shanbhogue AK, Prasad SR. Current concepts in the diagnosis and management of endometrial and cervical carcinomas. Radiol Clin North Am. 2013;51:1087–1110. Google Scholar Crossref
20. Renehan AG. Body-mass index and incidence of cancer: a systematic review and meta-analysis of prospective observational studies. Lancet. 2008;371:569–578. Google Scholar Crossref
21. Sjögren LL, Mørch LS, Løkkegaard E. Hormone replacement therapy and the risk of endometrial cancer: A systematic review. Maturitas. 2016;91:25-35. Google Scholar | Crossref
22. Kurman RJ, Carcangiu ML, Herrington CS, Young RH. Tumours of the Uterine Corpus. In: WHO classification of tumours of female reproductive organs. International Agency for Research on Cancer; 2014.121–155. Google Scholar | Crossref
23. Soliman PT. Association between adiponectin, insulin resistance, and endometrial cancer. Cancer. 2006;106:2376–2881. Google Scholar | Crossref
24. Soliman PT. Risk factors for young premenopausal women with endometrial cancer. Obstet Gynecol. 2005;105:575–580. Google Scholar | Crossref
25. Iglesias DA. Chapter 6 - Endometrial Hyperplasia and Carcinoma. In: Gynecologic Oncology: Clinical Practice and Surgical Atlas. 1st ed. 2011. Google Scholar | Crossref
26. Creasman W. Revised FIGO staging for carcinoma of the endometrium. Int J Gynaecol Obstet. 2009;105:109. Google Scholar | Crossref
27. Wu WJ, Yu MS, Su HY. The accuracy of magnetic resonance imaging for preoperative deep myometrium assessment in endometrial cancer. Taiwan J Obstet Gynecol. 2013;52:210–214. Google Scholar | Crossref
28. Kang S, Todo Y, Watari H. Risk assessment of lymph node metastasis before surgery in endometrial cancer: Do we need a clinical trial for low-risk patients? J Obstet Gynaecol Res. 2014;40:322–326. Google Scholar | Crossref
29. Epstein E, Blomqvist L. Imaging in endometrial cancer. Best Pract Res Clin Obstet Gynaecol. 2014;28:721–739. Google Scholar | Crossref
30. Kinkel K, Forstner R, Danza FM. Staging of endometrial cancer with MRI: Guidelines of the European Society of Urogenital Imaging. Eur Radiol. 2009;19:1565–1574. Google Scholar | Crossref
31. Abdaal A, Mushtaq Y, Khasati L. Post-menopausal bleeding –Is transvaginal ultrasound a useful first-line investigation in tamoxifen users? Post Reprod Health. 2018;24:72–78. Google Scholar | Crossref
32. Younesi L, Karimi Dehkordi Z, Safarpour Lima Z, Amjad G. Ultrasound screening at 11-14 weeks of pregnancy for diagnosis of placenta accreta in mothers with a history of cesarean section. Eur J Transl Myol. 2018;28:7772. Google Scholar | Crossref
33. Papadopoulos V, Tsiveriotis K, Decavalas G. The Role of Ultrasound in Endometrial cancer. Int J Clin Ther Diagn. 2015;1:1-4. Google Scholar | Crossref
34. ACOG committee opinion. The Role of Transvaginal Ultrasonography in Evaluating the Endometrium of Women with Postmenopausal Bleeding. 2018;131. Google Scholar | Crossref
35. Pelikan HMP, Trum JW, Bakers FCH. Diagnostic accuracy of preoperative tests for lymph node status in endometrial cancer: a systematic review. Cancer Imaging. 2013;13:314-322. Google Scholar Crossref
36. Faria SC, Sagebie T, Balachandran A, Devine C, Lal C, et al. Imaging in endometrial carcinoma. Indian J Radiol Imaging. 2015;25:137–147. Google Scholar Crossref
37. Stewart BW, Wild CP. World Cancer Report 2014. World Cancer Reports. World Health Organization, International Agency for Research on Cancer. Google Scholar
38. Kitajima K, Suzuki K, Senda M. Preoperative nodal staging of uterine cancer: is contrast-enhanced PET/CT more accurate than non-enhanced PET/CT or enhanced CT alone. Ann Nucl Med. 2011;25:511–519. Google Scholar Crossref
39. Grant P, Sakellis C, Jacene HA. Gynecologic oncologic imaging with PET/CT. Semin Nucl Med. 2014;44:461–478. Google Scholar Crossref
40. Savelli L, Ceccarini M, Ludovisi M. Preoperative local staging of endometrial cancer: transvaginal sonography vs. magnetic resonance imaging. Ultrasound Obstet Gynecol. 2008;31:560–566. Google Scholar Crossref
41. Lewin SN, Herzog TJ, Barrena Medel NI. Comparative performance of the 2009 International Federation of Gynecology and Obstetrics' staging system for uterine corpus cancer. Obstet Gynecol. 2010;116:1141–1149. Google Scholar Crossref
42. Alcazar JL, Orozco R, Martinez-Astorquiza CT. Transvaginal ultrasound for preoperative assessment of myometrial invasion in patients with endometrial cancer: a systematic review and meta-analysis. Ultrasound Obstet Gynecol. 2015. Google Scholar Crossref
43. Zahl Eriksson AG, Ducie J, Ali N. Comparison of a sentinel lymph node and a selective lymphadenectomy algorithm in patients with endometrioid endometrial carcinoma and limited myometrial invasion. Gynecol Oncol. 2016;140:394–399. Google Scholar Crossref
44. Cao K, Gao M, Sun YS, Li YL, Sun Y, et al. Apparent diffusion coefficient of diffusion weighted MRI in

endometrial carcinoma—relationship with local invasiveness. Eur J Radiol. 2012;81:1926–1930. Google Scholar Crossref

45. Manfredi R, Mirk P, Maresca G. Local-regional staging of endometrial carcinoma: role of MR imaging in surgical planning. Radiology. 2004;231:372-378.. Google Scholar Crossref
46. Sala E, Rockall AG, Freeman SJ. The added role of MR imaging in treatment stratification of patients with gynecologic malignancies: What the radiologist needs to know. Radiology. 2013;266:717–740. Google Scholar Crossref
47. Kehoe SM, Miller DS. The role of lymphadenectomy in endometrial cancer. Clin Obstet Gynecol. 2011;54:235–244. Google Scholar Crossref
48. Narayan K, Khaw P, Bernshaw D. Prognostic significance of lymphovascular space invasion and nodal involvement in intermediate- and high-risk endometrial cancer patients treated with curative intent using surgery and adjuvant radiotherapy. Int J Gynecol Cancer. 2012;22:260–266. Google Scholar Crossref
49. Sorbe B, Juresta C, Ahlin C. Natural history of recurrences in endometrial carcinoma. Oncol Lett. 2014;8:1800–1806. Google Scholar Crossref