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Ovarian cancer: An overview of classification, risk factors, diagnosis and treatment

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Abstract

Ovarian cancer (OC) is a complex and aggressive gynecological malignancy with poor prognosis, often diagnosed at advanced stages due to non-specific symptoms and lack of effective screening methods. The disease's heterogeneity and molecular characteristics pose significant challenges in diagnosis, treatment, and management. This review aims to summarize the current understanding of ovarian cancer, its classification, risk factors, diagnosis, and treatment strategies. OC is classified into several subtypes, including epithelial, mesenchymal, and germ cell tumors, each with distinct genetic markers and molecular characteristics. Advanced age, obesity, nulliparity, and family predisposition are significant risk factors. Diagnosis involves medical history evaluation, gynecological examination, serum CA-125 quantification, imaging tests, and histopathological examination. Treatment typically involves surgery, chemotherapy, and targeted therapy, with platinum-based chemotherapy being the standard of care. However, chemotherapeutic drug resistance remains a significant challenge. Immunotherapy, including immune checkpoint inhibitors, has shown promise in treating ovarian cancer.

Keywords: Ovarian Cancer; Chemotherapy Disease; Diagnosis; Immunotherapy; Targeted Therapy

1. Introduction

The prognosis for ovarian cancer (OC) is poor and it is frequently detected at an advanced stage. [1]. One of the most lethal gynecologic diseases is ovarian cancer (OC), which many have called a "silent killer." [2]. The processes by which ovarian cancer cells resist chemotherapeutic treatment are highly complicated and involve immunity, apoptotic pathways, autophagy, DNA damage repair, cell metabolism, oxidative stress, cell cycle regulation, cancer stem cells, multidrug resistance, and aberrant signaling pathways [3]. Most OC patients are discovered after the disease has advanced significantly. OC grows deeper in the pelvic cavity and has few clinical symptoms in its early stages [4]. The gynecologic malignancy known as ovarian cancer has a significant death rate. The primary cause of this tumor's high mortality is that it is frequently discovered when the disease is already advanced [5]. A common kind of gynecological cancer, ovarian cancer (OC) is known for its aggressiveness and propensity to spread. About three-quarters of OC cases are discovered at an advanced stage, making early diagnosis and treatment difficult due to its unusual presentation [6]. The 5-year survival rate of patients with OC has improved over the past few decades due to advancements in both traditional and innovative therapeutic approaches; however, the lack of early detection and the ineffectiveness of postoperative chemotherapy limit this progress [7]. OC is one of the most common tumors that kill women. It is a complex disease with complex molecular and genetic changes. Because OC recurrence is quite common, it is critical to understand the mechanisms behind medication resistance and pinpoint potential targets for rational targeted therapy [8]. Ovarian cancer (OC) is a serious medical problem that frequently manifests at an advanced stage, requiring immediate treatment [9]. Tumor-suppressor gene expression is changed by increased DNA methylation of promoter regions, which occurs early in the carcinogenesis process [10]. The rapid progression of ovarian cancer and the lack of early detection methods result in over 70% of patients receiving a diagnosis only after the disease is advanced [11]. The prognosis is poor because, despite advancements in surgery, chemotherapy, novel immunotherapies, and overall

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survival at all stages, many molecular processes in ovarian cancer contribute to tumor growth and therapeutic targets remain unknown [12]. Epithelial ovarian cancer (EOC) can be further classified into high-grade serous (52%), endometrioid (10%), clear cell (6%), and mucinous (6%) carcinomas, among others. Ovarian cancers are the eighth most common malignancy in females, making up 3.4% of all new cancer diagnoses in women worldwide [13]. Although non-epithelial ovarian cancer, epithelial ovarian cancer is identified in around 65% of cases at late stages (Stages III/IV). [14]. Additionally, ovarian cancer treatments were limited due to resistance and recurrence in patients with high-grade serous ovarian cancer [15]. Ovarian cancer can be classified into at least five distinct histological subtypes, each of which has distinct risk factors, cells of origin, molecular makeups, clinical characteristics, and therapeutic options. Ovarian cancer is a worldwide issue that lacks an efficient screening method and is usually discovered at an advanced stage. [16]. Ovarian carcinomas are a broad group of neoplasms that have historically been subclassified based on the kind and degree of differentiation. It is increasingly evident that each major histological variety has unique genetic defects that allow the tumor cells to deregulate specific signaling pathways, even though this heterogeneity is largely disregarded in the current clinical management of ovarian cancer. Additionally, among the most common histological classifications, low-grade and high-grade tumors appear to have somewhat diverse molecular pathophysiologies. [17] The response of immunotherapy to ovarian cancer is confined; however, by evaluating sensitive/resistant target treatment subpopulations based on tumor biomarker stratification, the predictiveness of immunotherapy response may be improved.[18]. Combining platinum-based chemotherapy with cytoreductive surgery is the current first-line treatment for ovarian cancer. For some patients, targeted therapy may be used, such as Poly(ADP-ribose) polymerase (PARP) inhibitors and anti-VEGF antibodies. There will be little to no change in the survival rate, though, as over half of the patients will return within two years. [19] The main obstacle to cancer treatment is treatment resistance. Ovarian cancer is unfortunately not an exception to treatment resistance, with platinum compound resistance being of particular significance. The length of the response to treatment including platinum was traditionally used to identify platinum resistance. [20]. In the development and spread of ovarian cancer, proteases are essential. Several proteases found in the ovarian tumor microenvironment are responsible for the breakdown and fragmentation of pericellular proteins as well as the remodeling of the extracellular matrix (ECM). The progression of cancer has been connected to a number of proteolytic processes, especially those that are aided by the matrix metalloproteinase (MMP) family. [21].

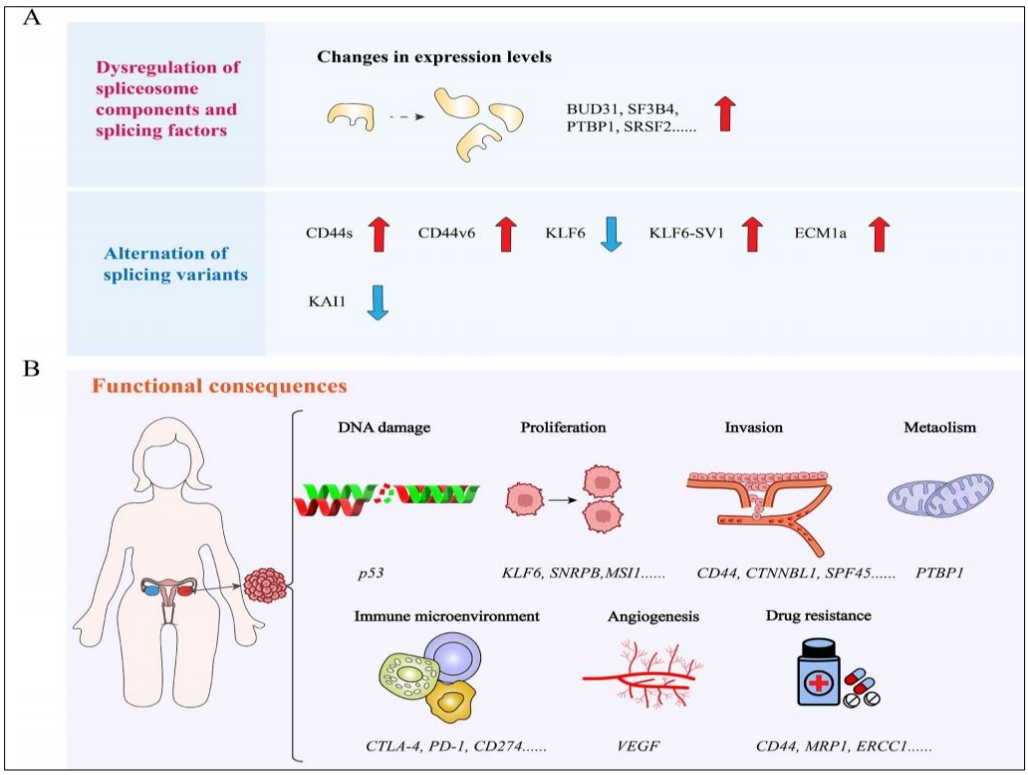

Figure 1 The profound impact of alternative splicing on human ovarian cancer. (A) Dysregulation of key regulators of the splicing process (spliceosome components and splicing factors), and alteration of splicing variants play crucial roles in ovarian cancer pathophysiology. Red arrows indicate upregulated expression levels, while blue arrows indicate downregulated expression levels. (B) The splicing-related genes involved in the progression of ovarian cancer are listed below each functional consequence in the figure. These genes are associated with processes including proliferation, apoptosis, invasion, metabolism, angiogenesis, DNA damage, drug resistance, and immune response [22]

1.1. Classification of ovarian cancer

- Epithelial tumors
- Mesenchymal tumors
- Mixed epithelial and mesenchymal tumors
- Sex-cord stromal tumors
- Germ cell tumors
- Monodermal teratoma and somatic type tumors which arise in dermoid cysts
- Other tumors
- Mesothelial tumors
- Soft tissue tumors
- Lesions that resemble tumors
- Lymphoid/myeloid tumors
- Secondary tumors [23].

1.2. Epithelial Tumors

There are various subcategories of epithelial malignancies, the most common type of ovarian cancer, and each has distinct genetic markers. As the most lethal of the gynecologic diseases, ovarian cancer is well known to have a significant impact on global health [24]. Due to a lack of detectable symptoms and screening methods, most EOC patients do not receive prompt treatment. Disease recurrence, which has a 48% 5-year overall survival (OS) rate, is another clinical challenge in EOC [14]. Epithelial ovarian cancer is a leading cause of cancer-related death for women, with 185,000 deaths and 295,000 new cases reported worldwide each year. Due to its asymptomatic nature and the lack of effective screening diagnostics, most patients are discovered at an advanced stage [25].

1.3. Symptoms

During early development, OC may present with non-specific symptoms such:

Abdominal distension, discomfort, appetite loss, or increased frequency of urination. Abdominal swelling brought on by the buildup of ascites is the most typical symptom in individuals with advanced diseases [26].

1.4. Diagnosis

Ovarian cancer is a diverse illness with different molecular, morphological, and histological features. Comprehending these molecular characteristics can help direct the diagnosis, prognosis, and therapy plans for ovarian cancer [27]. Medical history evaluation, gynecological examination, serum CA-125 quantification, imaging tests (transvaginal ultrasonography, computed tomography (CT), magnetic resonance imaging (MRI), and/or positron emission tomography (PET), and a requirement for a histopathological examination from either a diagnostic biopsy or, if feasible, a surgical specimen are the current methods for diagnosing OC [28]. Ascites, stomach issues, and/or pulmonary efusion are common in the later stages of OC, although nonspecific symptoms are frequently associated with the early stages. Women with symptoms suggestive of OC are recommended to undergo pelvic ultrasonography, laboratory testing with CA 125, and physical examination at the first level [II, A]. High levels of HE4 are indicative of malignancy with similar sensitivity to CA 125 but higher specificity. Both CA 125 and HE4 are taken into account by the Risk Ovarian Malignancy Algorithm (ROMA) when assessing the likelihood that adnexal tumors will be malignant. [29]. Surgeons frequently have to make decisions about which surgical operations to perform intraoperatively because patients frequently have severe diseases upon diagnosis that necessitate sophisticated surgical procedures. This makes it challenging to anticipate the best postoperative care in advance [30]. To greatly enhance the clinical outcomes of OC patients, it is essential to thoroughly investigate its tumorigenic pathways to identify possible diagnostics, treatment targets, and biomarkers unique to OC [31].

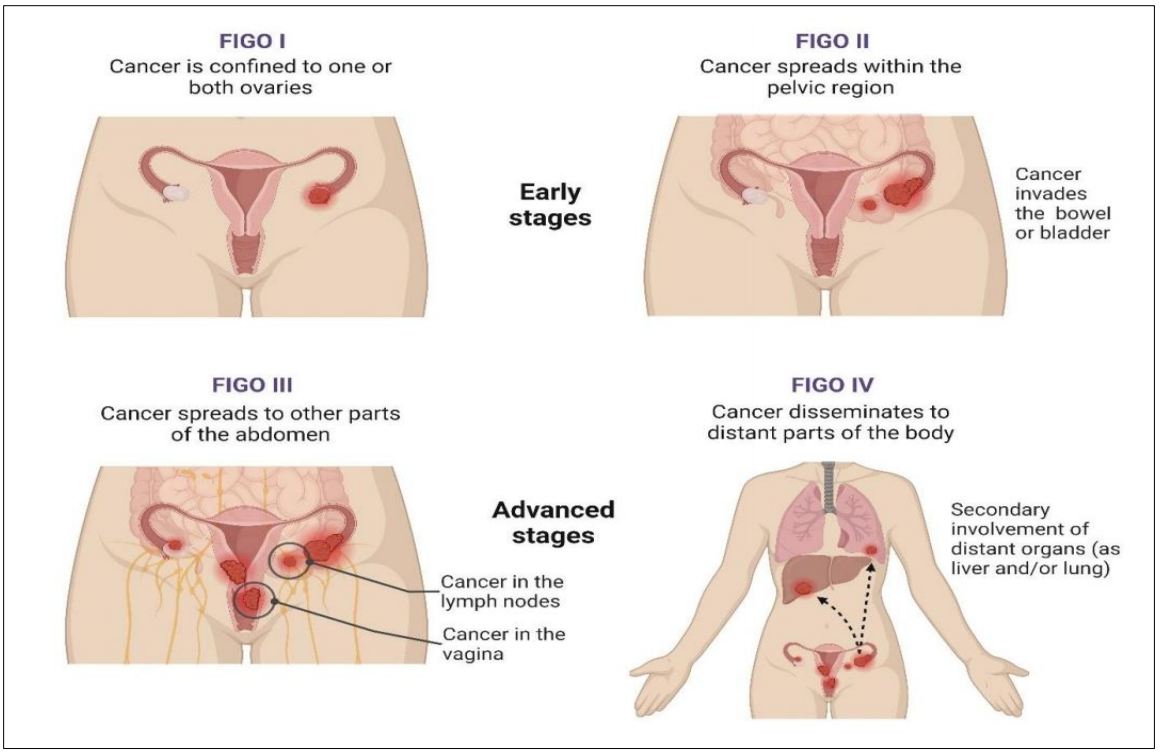

Figure 2 Stages of ovarian cancer. [28]

2. Risk factors

Advanced age, obesity, nulliparity or pregnancies after the age of 35, hormone replacement therapy, and family predisposition are risk factors for ovarian cancer. The family history of both breast and ovarian cancer is the biggest risk factor for ovarian cancer. Genetic susceptibility accounts for 10–15% of ovarian malignancies and up to 20% of high-grade serous ovarian carcinomas. Thus, for all cases of ovarian cancer, the National Comprehensive Cancer Network (NCCN) advises genetic testing. Both sporadic (non-hereditary) and hereditary (familial) ovarian tumors are possible [24]. The family history of both breast and ovarian cancer is the biggest risk factor for ovarian cancer. Genetic susceptibility accounts for 10–15% of ovarian malignancies and up to 20% of high-grade serous ovarian carcinomas. For this reason, genetic testing is advised for all ovarian cancers by the National Comprehensive Cancer Network (NCCN) [32].

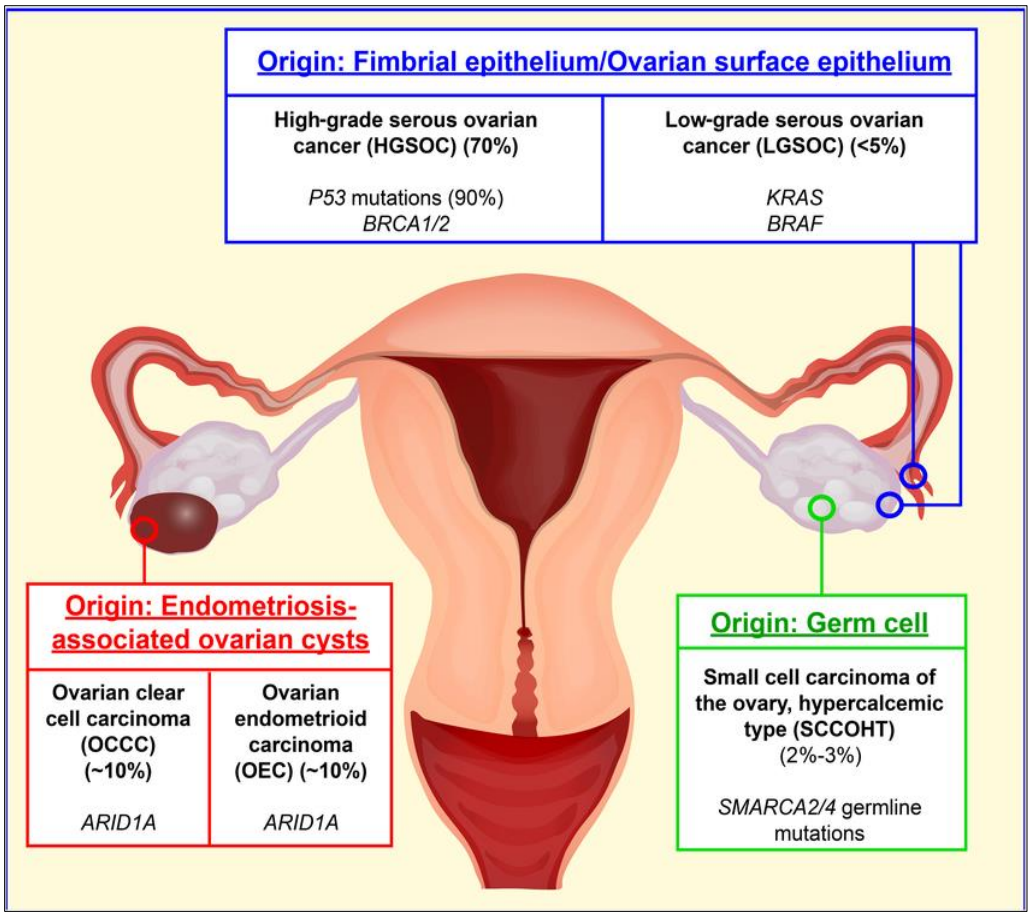

Figure 3 Current understanding of the putative tissues of origin for key ovarian cancer subtypes, and the most frequent mutations associates with each type [33]

3. Current treatment of ovarian cancer

To treat ovarian cancer, platinum/gemcitabine and taxane-based chemotherapy are used after excellent debulking surgery. [34] Analyzing the expression of biomarkers produced significant findings for discovering new treatment targets and forecasting the onset and course of several malignant and noncancerous disorders [35].

3.1. Immunotherapy with immune checkpoint inhibitors (ICIs) in ovarian cancer

Cancer treatment has been transformed by immunotherapy, with ICIs being a key and promising component in the fight against a variety of cancers. Blocking immune response-inhibiting processes is the goal of these anticancer drugs [11]. Immunotherapy's function in treating ovarian cancer is constantly changing, making it a viable treatment option. The expression of PD-1/PDL1 is higher in endometriosis-associated ovarian cancer than in benign lesions, suggesting that checkpoint medicines that target the expression of PD-1 and PD-L1 in EAOC are promising. [36]. For OC, several immunotherapies are presently being explored, including as tumor vaccines, checkpoint inhibition, and CAR-based treatments. The use of immune checkpoint inhibitors (ICIs) to treat ovarian cancer is now the subject of several clinical investigations. T-cell activity is reduced by the PD-1/PD-L1 axis, which makes PD-1 a viable target for immunotherapy in several malignancies [37].

3.2. Combination Therapies

Combination therapy, which involves combining two or more therapeutic drugs, is a fundamental component of cancer treatment. Combining anticancer medications increases efficacy over monotherapy because it hits important pathways in a way that is typically additive or synergistic. This strategy may lessen medication resistance while also offering therapeutic anti-cancer advantages such lowering the development and metastasis potential of tumors, stopping mitotically active cells, lowering the numbers of cancer stem cells, and triggering apoptosis. [38].

3.3. Ovarian cancer therapy

The first line of treatment for advanced ovarian cancer is surgery, which is followed by chemotherapy. The stage and adjuvant treatment of ovarian cancer are determined by surgery for debulking. For six cycles, intravenous or intraperitoneal administration of platinum-containing doublet therapy usually in combination with paclitaxel has been the accepted standard of care [39]. Chemotherapeutic drug resistance in OC can result from a number of biological mechanisms, such as epigenetic modifications, deregulation of signaling pathways, and changes in plasma membrane transport with drug accumulation [40].

4. Role of surgery in ovarian cancer

Chemotherapy is a proven method of treatment. Since complete cytoreduction is one of the most significant prognostic markers of survival, the goal of surgery should be the entire eradication of macroscopic disease [41]. Patients who are too old or have concomitant conditions to receive the best cytoreduction may be treated with neoadjuvant chemotherapy and interval debulking surgery. Paclitaxel/carboplatin and pegylated liposomal doxorubicin/carboplatin are frequently included in the usual chemotherapy regimen. Olaparib is advised for patients in remission who have BRCA mutations after receiving initial platinu-based chemotherapy [42]. The mainstay of treatment for LGSOC is surgery. It emphasizes the significance of R0 resection due to the significant influence of LGSOC's relative treatment resistance and satisfactory cytoreductive surgery (CRS) on the prognosis [43]. The first line of treatment for advanced ovarian cancer is surgery, which is followed by chemotherapy. The stage and adjuvant treatment of ovarian cancer are determined by surgery for debulking. For six cycles, intravenous or intraperitoneal administration of platinum-containing doublet therapy usually in combination with paclitaxel has been the accepted standard of care [39]. Chemotherapeutic drug resistance in OC can result from a number of biological mechanisms, such as epigenetic modifications, deregulation of signaling pathways, and changes in plasma membrane transport with drug accumulation [40]. Ovarian cancer chemotherapy usually consists of three to six cycles of carboplatin (CB), a platinum alkylating agent, and paclitaxel, a taxane that inhibits the development of microtubules, every three weeks, or as tolerated [44].

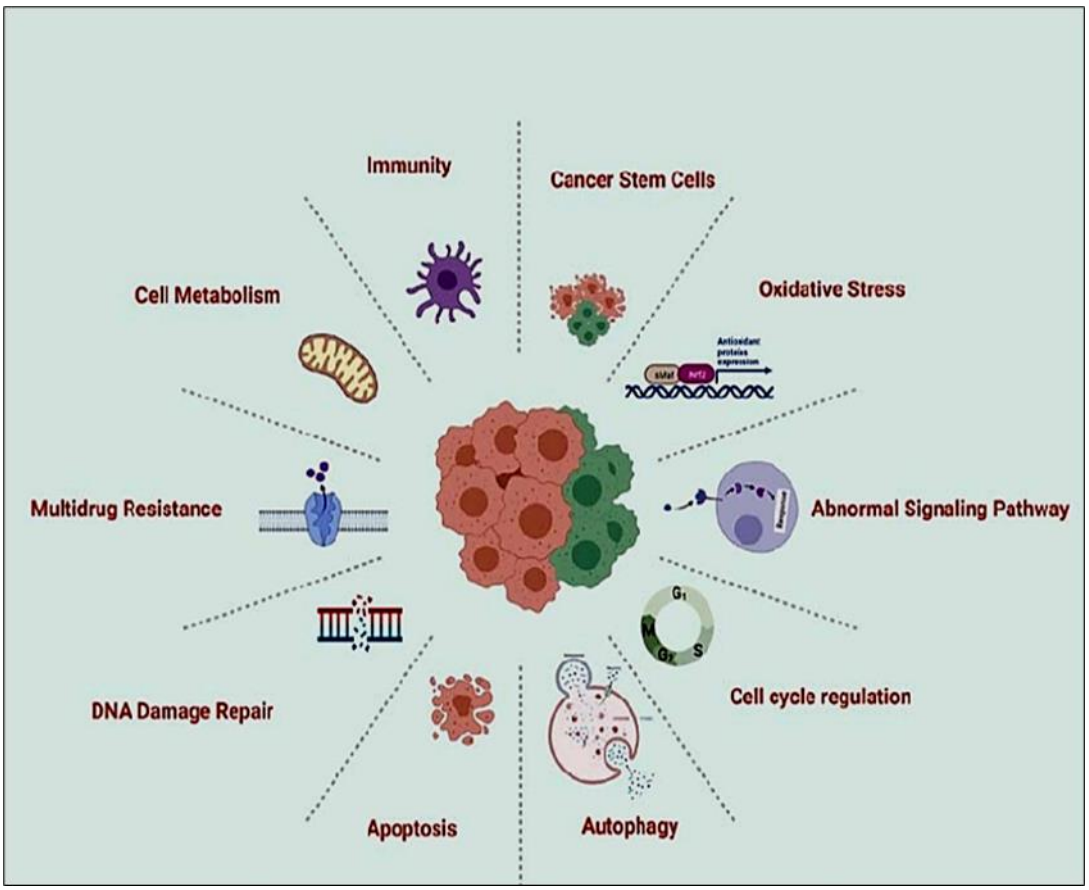

Figure 4 Schematic overview of the mechanisms of platinum-based chemotherapy resistance in ovarian cancer [4]

5. Conclusion and future directions

Although there has been some progress in 5-year survival rates over the previous few decades, ovarian cancer remains a major clinical problem. Since Ovarian Cancer is asymptomatic and the present diagnostic and screening techniques cannot identify the disease in its early stages, most instances are discovered after Ovarian Cancer has spread. Nowadays, there are ineffective methods for detecting Ovarian Cancer in its early stages or trustworthy prognostic indicators for forecasting therapy outcomes and determining medication schedules. The molecular characteristics of ovarian cancer have been better understood in recent years, and new targeted medicines based on oncogenes have been proposed as an alternative to conventional systemic therapies. Numerous novel approaches to enhance patient outcomes are on the horizon. In recent years, several novel approaches and substances have been created to target the features of cancer, including targeted therapy, immunotherapy, gene therapy, and drug conjugates.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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