

Review

Endocrine treatment options for advanced breast cancer – the role of fulvestrant

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Abstract

For many years, tamoxifen has been the 'gold standard' amongst anti-oestrogen therapies for breast cancer. However, the selective aromatase inhibitors (AIs), anastrozole, letrozole and exemestane, have demonstrated advantages over tamoxifen as first-line treatments for advanced disease. Anastrozole is also more effective as an adjuvant treatment in early, operable breast cancer and is being increasingly used in the adjuvant setting. Generally, the selective oestrogen receptor modulators (SERMs), such as toremifene, droloxifene, idoxifene, raloxifene, and arzoxifene, show minimal activity in tamoxifen-resistant disease and show no superiority over tamoxifen as first-line treatments. In addition to these agents, other treatment options for advanced disease include high-dose oestrogens and progestins. Response rates for high-dose oestrogens and tamoxifen are similar, but the use of oestrogens is limited by their toxicity profile. Consequently, there is a need for new endocrine treatment options for breast cancer, particularly for use in disease that is resistant to tamoxifen or AIs. Fulvestrant ('Faslodex') is a new type of steroidal oestrogen receptor (ER) antagonist that downregulates cellular levels of the ER and progesterone receptor and has no agonist activity. This paper reviews the key efficacy and tolerability data for fulvestrant in postmenopausal women in the context of other endocrine therapies and explores the potential role of fulvestrant within the sequencing of endocrine therapies for advanced breast cancer.

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1. Introduction

Fulvestrant ('Faslodex') is a new type of endocrine agent, an oestrogen receptor (ER) antagonist that has

no agonist effects. It downregulates cellular levels of the ER, resulting in the decreased expression of the progesterone receptor (PgR). This paper reviews key efficacy and tolerability data for fulvestrant in the context of other endocrine therapies and explores the potential role of fulvestrant within the sequence of endocrine agents used for treating postmenopausal women with advanced breast cancer.

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2. SERMs, oestrogens and ER downregulators

Tamoxifen is a non-steroidal triphenylethylene agent that has been the ‘gold standard’ selective oestrogen receptor modulator (SERM) amongst anti-oestrogen therapies since the 1970s. Tamoxifen is an oestrogen antagonist in breast tissue, but acts as an oestrogen agonist in the bones and endometrium. This spares bone mineral density and serum cholesterol levels from the full effects of oestrogen deprivation [1,2], but is also associated with undesirable side effects such as an increased risk of endometrial cancer and thromboembolic events [3]. The selective aromatase inhibitors (AIs), anastrozole, [4,5] letrozole [6,7] and exemestane [8], have since been shown to have advantages over tamoxifen as first-line treatments for advanced disease, but a review of these data is beyond the scope of this paper.

Several new anti-oestrogens have been developed since tamoxifen, some with similar mechanisms of action to tamoxifen and some that are very different. First-generation SERMs, such as toremifene, droloxifene and idoxifene, are tamoxifen analogues based on the non-steroidal triphenylethylene structure. The structurally distinct second- and third-generation SERMs (raloxifene, arzoxifene, EM-800 and ERA-923) are also non-steroidal, but are ‘fixed-ring’ benzothiophene derivatives, yet appear to retain some oestrogen agonist activity. In contrast, fulvestrant, which has a steroidal structure closely resembling oestradiol, is a new ER antagonist that has no agonist activity. Fig. 1 shows the chemical structures of oestradiol, fulvestrant, tamoxifen and raloxifene. Anti-oestrogens are generally compared on the basis of their activity in tamoxifen-resistant disease, their ability to delay the development of resistance and their side-effect profiles.

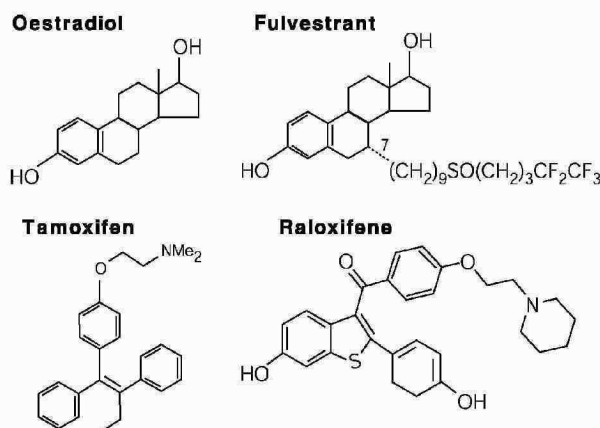


Fig. 1. Chemical structures of oestradiol, fulvestrant, tamoxifen and raloxifene.

3. Activity versus tamoxifen and in tamoxifen-resistant disease

3.1. SERMs

Several studies have confirmed that toremifene is cross-resistant with tamoxifen in advanced disease [9–11]. Both these agents display similar efficacy and tolerability in the advanced [12,13] and adjuvant settings [14]. Efficacy results for the structurally related, droloxifene [15–17] and idoxifene [18,19], have both been disappointing when either compared directly with tamoxifen or when used in tamoxifen-resistant disease; the development of these agents has now ceased.

The second-generation, ‘fixed ring’ SERM arzoxifene has also shown poor efficacy in tamoxifen-resistant disease [20]. Furthermore, a randomised Phase III trial of arzoxifene *versus* tamoxifen was terminated early because of a lack of efficacy (Buzdar A, data not shown). Raloxifene also shows low efficacy in tamoxifen-resistant disease [21], but has shown promise in breast cancer prevention [22,23] and is currently being tested in this setting in the STAR (Study of Tamoxifen and Raloxifene) trial [24]. ERA-923 is a second-generation SERM that is currently in development for the treatment of tamoxifen-refractory metastatic breast cancer, but no efficacy data for this agent are available to date. In summary, the SERMs as a group have thus far shown no superiority over tamoxifen as first-line advanced breast cancer treatments and minimal activity in tamoxifen-resistant disease.

3.2. High-dose oestrogens

Prior to the introduction of tamoxifen, high-dose oestrogens – such as diethylstilboestrol (DES) or ethinyl oestradiol – were generally considered the endocrine treatment of choice for postmenopausal women with breast cancer [25]. Subsequently, the use of oestrogens declined, but recent trial data have shown these drugs to have similar efficacy to tamoxifen [26] and to produce responses, even in those who have received extensive prior endocrine therapy [27]. However, the use of these agents is limited by their toxicity profile.

4. Fulvestrant – a novel oestrogen antagonist that downregulates cellular levels of ER

4.1. Biological effects

Fulvestrant blocks the trophic actions of oestrogen without exerting any partial agonist effects. Fulvestrant entered clinical development after preclinical studies suggested it was active in tamoxifen-resistant breast

cancer [28–30]. Fulvestrant acts by competing with oestradiol for binding to the ER and has a higher affinity for the ER than tamoxifen [31]. Fulvestrant downregulates expression of ER and decreased activity of the ER pathway results in reduced expression of the PgR and reduced proliferative and cell turnover indices both *in vitro* [32–35] and in the clinical setting [36,37].

In the presence of fulvestrant, ER is rapidly depleted, producing a loss of functional response to oestrogens after relatively short periods of time in *in vitro* studies. This is in contrast with the increases in ER levels seen on either oestrogen withdrawal or tamoxifen treatment [32]. The effects of three different fulvestrant doses and one dose of tamoxifen on cellular ER, PgR and Ki67 levels were investigated in a study of postmenopausal women with primary breast cancer. Patients received either a single intramuscular (i.m.) injection of fulvestrant 50, 125 or 250 mg, or oral tamoxifen 20 mg, daily for 14–21 days, prior to surgery of curative intent. Fig. 2 demonstrates the dose-dependent reductions in ER and

PgR levels with fulvestrant treatment. Reductions in ER levels were statistically significant for all fulvestrant doses compared with placebo and for the 250 mg dose compared with tamoxifen. There were statistically significant reductions in PgR levels with fulvestrant 125 and 250 mg compared with placebo. In contrast, tamoxifen treatment produced significant increases in PgR levels compared with placebo, probably as a result of its oestrogen agonist activity. All doses of fulvestrant significantly reduced the Ki67 labelling index, but there were no significant differences compared with tamoxifen [36].

4.2. Clinical efficacy

4.2.1. Fulvestrant versus anastrozole

Two large Phase III trials (Trial 0021: North America; Trial 0020: Rest of World [Europe, South Africa, Australia]) have compared the efficacy and tolerability of fulvestrant with anastrozole, in postmenopausal women with advanced breast cancer who had progressed on prior endocrine treatment (mainly tamoxifen). Patients were randomised to receive either fulvestrant 250 mg, by monthly i.m. injection or a daily oral dose of anastrozole 1 mg and continued treatment until disease progression or withdrawal.

In the North American trial, 400 patients received double-blind, randomised treatment with either fulvestrant (as 2 × 2.5 ml i.m. injections) ($n = 206$) or oral anastrozole ($n = 194$) and were followed for a median of 16.8 months. Fulvestrant was found to be as effective as anastrozole in terms of time to progression (TTP) (Hazard Ratio (HR): 0.92; 95% Confidence Interval (CI) 0.74–1.14; $P = 0.43$); median TTP was 5.4 months with fulvestrant and 3.4 months with anastrozole. Objective response (OR) rates were 17.5% for both treatments and clinical benefit (complete response (CR) + partial response (PR) + stable disease (SD) ≥ 24 weeks; CB) rates were 42.2% and 36.1% for fulvestrant and anastrozole, respectively. Median duration of response (DOR; from randomisation to progression) was 19.0 months for fulvestrant compared with 10.8 months for anastrozole. An analysis using all randomised patients, defined for responders as the time from onset of response to disease progression and for non-responders as zero, showed that mean DOR was significantly greater for fulvestrant compared with anastrozole; the ratio of average response durations being 1.35 (95% CI 1.10–1.67; $P < 0.01$) [38].

In the Rest of World (open) trial, 451 patients were randomised to receive either fulvestrant as a single 5 ml i.m. injection ($n = 222$) or anastrozole orally ($n = 229$) and were followed for a median of 14.4 months. Again, fulvestrant was shown to be at least as effective as anastrozole in terms of TTP (HR: 0.98; 95% CI 0.80–1.21; $P = 0.84$); median TTP was 5.5

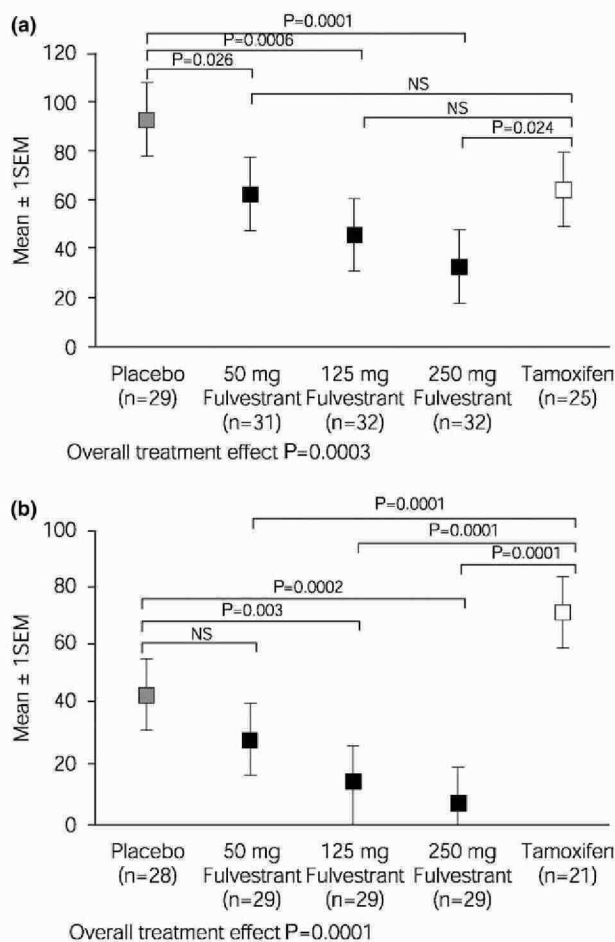


Fig. 2. Post-treatment mean H-scores for cellular: (a) oestrogen receptor (ER) and (b) progesterone receptor (PgR) levels. Figure reproduced with the permission of Cancer Research [36]. SEM, standard error of the mean; NS, non-significant.

months for fulvestrant and 5.1 months for anastrozole. OR rates were 20.7% for fulvestrant and 15.7% for anastrozole (odds ratio: 1.38; 95% CI 0.84–2.29; $P = 0.20$). CB rates were 44.6% for fulvestrant and 45.0% for anastrozole and the median DOR was 15.0 months and 14.5 months for fulvestrant and anastrozole, respectively. In addition, mean DOR using all randomised patients was significantly greater for fulvestrant compared with anastrozole, the ratio of average response durations being 1.27 (95% CI 1.05–1.55; $P = 0.01$) [38].

The two Phase III trials were prospectively designed to be evaluated both individually and using combined data. A combined analysis of all patients included in both second-line Phase III trials demonstrated a significant 30% increase in mean DOR in patients treated with fulvestrant (ratio of average response durations: 1.30; 95% CI 1.13–1.50; $P < 0.01$; Fig. 3) [40]. In addition to confirming the efficacy of fulvestrant that was observed in the individual trials, retrospective analyses of these combined data also showed fulvestrant had similar efficacy (in terms of OR rate, CB rate and DOR) to anastrozole in the subgroup of patients with visceral metastases. The median DOR in patients with visceral metastases was 17.5 months in the fulvestrant group compared with 11.7 months in the anastrozole group. Notably, in the subgroup of patients with visceral metastases only, seven of 69 (10%) fulvestrant-treated patients achieved a CR, compared with one of 86 (1%) anastrozole-treated patients [41].

The data from these two trials reiterate that fulvestrant is a novel agent with levels of activity in tamoxifen-resistant disease that distinguish it from SERMs and other anti-oestrogens. Furthermore, fulvestrant was at least as effective as anastrozole in this setting. In addition, retrospective analysis evaluating combined questionnaire data from the two trials showed that patients can retain sensitivity to other endocrine agents (anastrozole, letrozole, and megestrol acetate) after receiving second-line fulvestrant (Table 1) [42].

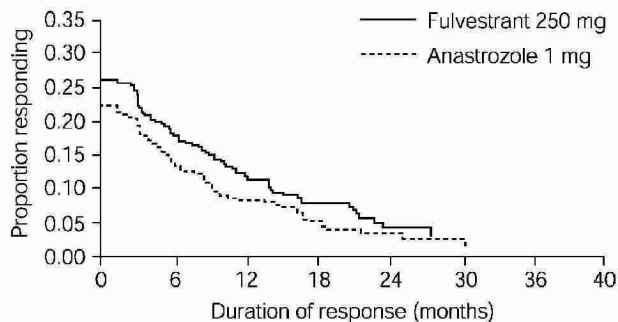


Fig. 3. Kaplan–Meier estimates for duration of response from onset of response to disease progression (combined analysis of all randomised patients included in Phase III trials). Copyright © 2003 American Cancer Society. Reprinted by permission of Wiley - Liss, Inc., a subsidiary of John Wiley & Sons, Inc. [40].

Table 1

Response to subsequent therapy in patients who derived CB from fulvestrant

	Number of patients				Total
	CR	PR	SD \geq 24 weeks	PD	
Patients who derived CB from first-line fulvestrant					
Anastrozole	1	0	8	7	16
Letrozole	0	1	0	4	5
Fadrozole	0	0	1	0	1
Tamoxifen	0	1	7	2	10
Megestrol acetate	0	0	1	0	1
Medroxyprogesterone acetate	0	0	0	2	2
Patients who derived CB from second-line fulvestrant					
Anastrozole	0	1	13	23	37
Letrozole	0	2	3	3	8
Formestane	0	0	0	1	1
Megestrol acetate	0	1	5	2	8

Table adapted from [44] and [42], with the permission of Breast Cancer Research and Treatment.

CR, complete response; PR, partial response; SD, stable disease; PD, disease progression; CB, Clinical benefit.

4.2.2. Fulvestrant versus tamoxifen

Fulvestrant and tamoxifen have been compared as first-line treatments in a trial including postmenopausal women with advanced breast cancer. Approximately, 20–25% of patients in this trial had previously received adjuvant tamoxifen, but no patients received prior endocrine therapy for advanced disease. In this study, the median TTP was 6.8 months in the fulvestrant group and 8.3 months in the tamoxifen group. The between-treatment difference was non-significant (HR: 1.18; 95% CI 0.98–1.44; $P = 0.088$), but the upper limit of the 95% CI (1.44) did not satisfy the pre-defined criterion for non-inferiority (≤ 1.25) of fulvestrant compared with tamoxifen. OR rates for fulvestrant and tamoxifen were similar (31.6% versus 33.9%; $P = 0.45$), but more tamoxifen-treated patients overall achieved CB (62.0% versus 54.3%; $P = 0.03$) [43]. Median DOR (from randomisation to progression) was 17.3 and 19.8 months for fulvestrant and tamoxifen, respectively [43]. In the prospectively defined subgroup of patients with ER-positive and/or PgR-positive tumours, median TTP was similar for the fulvestrant and tamoxifen treatment groups (8.2 months versus 8.3 months; HR: 1.10; 95% CI 0.89–1.36; $P = 0.39$) [43].

Subsequent exploratory analyses of response by hormone receptor status showed that in the subgroup of patients with tumours expressing both ER and PgR 44.3% of fulvestrant-treated patients and 29.8% of patients treated with tamoxifen experienced an OR ($P = 0.02$) [43]. However, the authors note that these data were retrospectively derived and therefore should be interpreted with caution in terms of their clinical significance. Further confirmatory data are required. In addition, patients who responded to first-line treatment with

fulvestrant may retain sensitivity to subsequent endocrine therapy with a variety of agents, including anastrozole, letrozole, fadrozole, tamoxifen, and megestrol acetate (Table 1) [44]. This is similar to the findings noted above where tumours appeared to retain sensitivity to other endocrine agents following second-line treatment with fulvestrant [42]. It therefore appears that the use of fulvestrant does not *per se* lead to end-stage hormone insensitivity.

4.3. Tolerability

In the second-line trials, both fulvestrant and anastrozole were well tolerated, with few patients in either group withdrawing due to treatment-related adverse events (0.9% and 1.2% of the fulvestrant- and anastrozole-treated patients, respectively). Overall, the incidence and severity of events (generally mild to moderate) were similar between groups; the most common events in both groups included hot flushes, nausea, asthenia, pain, headache and pharyngitis. The incidence of events considered important with endocrine therapy such as weight gain, thromboembolic events and vaginitis was low for both fulvestrant and anastrozole [38,39].

The use of placebo injections in the North American trial indicated that fulvestrant was well tolerated locally and that injection-site reactions were related to the injection itself, as 27% of patients receiving fulvestrant compared with 23% of those receiving placebo reported injection-site reactions [38]. Overall, 86 fulvestrant courses (4.6%) of the total 1879 and 71 placebo courses (4.4%) of the total 1624 resulted in an injection-site reaction. This is supported by the clinical experience of physicians administering the 2 × 2.5 ml fulvestrant regimen in the US. Here, nursing guidelines have previously suggested that, for adults, i.m. injections into large muscles such as the gluteus medius, should not usually exceed 4 ml [45], therefore in the trial it was decided to use 2 × 2.5 ml i.m. injections, one into each buttock, rather than a single 5 ml injection [38]. The pharmacokinetics of these two regimens have previously been shown to be similar [46]. Moreover, since the 2.5 ml injections were so well tolerated, most US institutions now prefer to administer fulvestrant as a single 5 ml i.m. injection, thereby reducing the number of injections given to the patient (Astra-Zeneca, data on file).

In the fulvestrant *versus* tamoxifen comparative study, both treatments were well tolerated with no statistically significant differences in the incidence of prospectively defined adverse events of gastrointestinal disturbances, hot flushes, vaginitis and thromboembolic disease. However, the incidence of hot flushes was lower in the fulvestrant group than in the tamoxifen group and the difference approached statistical significance (17.7% *versus* 24.7%; $P = 0.0501$) [43].

5. Fulvestrant – the US experience

In April 2002, the US Food and Drug Administration (FDA) granted approval for fulvestrant to be used for the treatment of hormone receptor-positive metastatic breast cancer in postmenopausal women with disease progression following anti-oestrogen therapy. The use of fulvestrant as second-line therapy is increasing, although the drug continues to be used in patients who have progressed on both tamoxifen and an AI. Data from the two Phase III studies of fulvestrant *versus* anastrozole suggest that fulvestrant is as effective as an AI in the second-line setting and that DOR may, in fact, be longer with fulvestrant treatment [38,39].

In the US, there appears to be a general underutilisation of hormonal therapy and a lack of differentiation between fulvestrant and other hormonal agents such as anastrozole. At several oncology meetings in the US, surveys of treatment practice amongst US oncologists suggest that US physicians often favour chemotherapy in situations where European clinicians prefer further endocrine treatment. Furthermore, US physicians may utilise endocrine treatment for a shorter duration and switch to chemotherapy earlier than their European counterparts (Jones SE, data not shown).

The personal experiences of the US physicians involved in the US Phase III fulvestrant *versus* anastrozole trial are in agreement with the formal DOR analysis, which suggest that, on average, fulvestrant-treated patients respond for approximately 30% longer than those treated with anastrozole [40]. One investigator had 27 patients included in the Phase III US trial, of these, five have had responses of >3 years (two for >4 years), four of these patients have now relapsed and have been unblinded and all had been receiving fulvestrant and one is currently continuing double-blind treatment (Jones SE, data not shown). A second investigator had 16 patients entered in the same trial; four of these patients (25%) had CB for 20–44 months three of whom were found to be receiving fulvestrant after unblinding (Come SE, Personal Communication) (Table 2). This emphasises the fact that there appears to be a population of patients who have an extremely long DOR with fulvestrant. Furthermore, personal experiences from these physicians have shown that parenteral dosing can also be beneficial over oral dosing for some patients, particularly those demonstrating poor compliance with oral therapies.

6. Sequencing of endocrine treatments

Because of the toxicity associated with chemotherapy, it would be advantageous in appropriate patients to extend the endocrine treatment window, thus deferring the initiation of more toxic treatments that are associated with acute and more severe side effects. Endocrine treat-

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