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Effect of chemotherapy and radiotherapy on prolactin levels of cancer patients in Enugu metropolis

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Abstract

Chemotherapy, a common treatment method for various cancers involves the use of cytotoxic drugs to eliminate cancer cells while radiotherapy uses ionizing radiation to target and kill cancer. Each of these methods has impact on endocrine function. This study investigated how prolactin levels vary among cancer patients undergoing chemotherapy, radiotherapy, and combined chemo-radiotherapy in Enugu metropolis. A total of forty-nine [49] participants were recruited, comprising twenty-nine [29], 14 males and 15 female cancer patients undergoing either radiotherapy or chemotherapy and twenty [20] apparently healthy control subjects. Blood samples were collected, serum extracted and analyzed for prolactin concentration using the Enzyme-Linked Immunosorbent Assay [ELISA] method. Data were analyzed using SPSS Inc. Chicago, IL USA [Student's t-Test and Tukey's Post-hoc test] and significance was determined at $P < 0.05$. Serum prolactin concentrations were compared with those of non-cancer control subjects. The results revealed that prolactin levels were generally higher among cancer patients treated with chemotherapy and those undergoing radiotherapy exhibited lower mean prolactin concentrations compared to those receiving chemotherapy and combined groups. Statistical analysis showed no significant difference [$P > 0.05$] in prolactin levels among the different treatment groups, however, when cancer patients were compared to non-cancer controls, prolactin levels were significantly reduced ($P < 0.05$). Gender showed no significant effect on prolactin concentration. These findings suggest that while chemotherapy could raise prolactin and radiotherapy slightly lowered prolactin secretion, the overall effect observed is more likely associated with the presence of malignancy than with treatment modality.

Keywords: Prolactin; Radiotherapy; Chemotherapy; Cancer; Elisa

1. Introduction

Cancer remains one of the leading causes of morbidity and mortality globally. The management of cancer involves various treatment modalities, including radiotherapy and chemotherapy, which aim to eliminate malignant cells but can also affect normal physiological and endocrine functions. Radiotherapy uses high energy radiation to kill or damage cancer cells and its physiological effects are based on the interaction of radiation with biological tissues [1], while chemotherapy uses cytotoxic drugs that interfere with cell division and replication.

Prolactin, a peptide hormone secreted by the anterior pituitary gland, is involved in reproductive and metabolic regulation, immune modulation, and cellular differentiation. Its secretion is influenced by several physiological and pathological conditions, including stress and malignancy. In cancer, abnormal prolactin levels have been implicated in tumor progression and altered endocrine responses.

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Prolactin plays critical roles in lactation, reproduction, and immune-regulation and its secretion is regulated by a complex interplay of hormonal signal, feedback mechanism [2]. It promotes the growths and development of the mammary tissues during pregnancy and triggers milk synthesis during lactation [3]. Prolactin levels are typically higher during pregnancy and lactation but can also be elevated in some pathological malignancies [4]. Elevated prolactin levels have been observed in different malignancies and in patients undergoing cancer therapies.

Prolactin can act directly on cancer cells via the prolactin receptor (PRLR) expressed in many tissues including breast, prostate and pituitary tumors. The binding to its receptor activates several signaling pathways that promotes cell proliferation and survivals [5], and excessive proliferation enhanced and facilitates tumor growths of breast cancer cell lines [6,]. Measurements of elevated prolactin levels can serve as a potential biomarker for tumor progression and prognosis; treatments aimed at blocking the prolactin receptors or inhibiting its synthesis which would provide new strategies for certain type of cancer managements [8] Understanding the impact of these treatments on prolactin concentration is important for evaluating treatment-related stress and hormonal imbalance.

Previous studies have shown that both chemotherapy and radiotherapy can alter pituitary function and influence prolactin secretion [9-11].

Chemotherapy by its nature often leads to endocrine disruption due to its cytotoxic effects on tissues vital for hormonal regulations such as the ovaries and the pituitary gland [12]. It has been shown to cause hyper-prolactinaemia either through direct toxicity to the pituitary or hypothalamus or by inducing ovarian failure, which indirectly affect prolactin regulation. Radiotherapy when administered in areas close to the pituitary glands or brain can directly impact endocrine function by damaging the hypothalamic-pituitary axis leading to abnormal hormone secretion including elevated prolactin level [13]. This study therefore evaluates the effect of radiotherapy and chemotherapy on prolactin levels in cancer patients in Enugu metropolis.

2. Materials and methods

This was a hospital-based comparative study involving cancer patients receiving treatment at major hospitals in Enugu metropolis and age-matched non-cancer controls. Patients were grouped based on treatment type: chemotherapy only, radiotherapy only, and combined chemo-radiotherapy. A total of forty-nine [49] participants were recruited, including twenty-nine [29] cancer patients undergoing treatment and twenty [20] apparently healthy controls

Venous blood samples [5 ml] were collected from each participant and centrifuged to obtain serum. Serum prolactin concentrations were measured using a standardized enzyme-linked immunosorbent assay [ELISA] [14]. . The high specific enzymatic monoclonal antibody reaction test produced a colour change and the intensity of the colour is directly proportional to the concentration of prolactin in the sample and from different control standard curve plotted, the amount of prolactin in the samples was read [15].

Ethical approval was obtained from university of Nigeria teaching hospital health research ethics committee. Data were analyzed using Student;s t-Test and post-hoc test. Results were expressed as Mean ± Standard Error of Mean [SEM]. Differences among groups were determined using one-way ANOVA, with $P < 0.05$ considered statistically significant.

3. Results

Table 1 Prolactin level of cancer patients undergoing chemotherapy and radiotherapy in Enugu metropolis

Study groups	Mean ± S.D. [ng/ml] [Male N=14]	Mean ± S.D. [ng/ml] [female N=15]	p-value
Chemotherapy	13.3± 6.2	9.9 ± 2.3	0.812
Radiotherapy	9.6 ± 9.24	8.03 ± 4.48	0.186
Chemotherapy/radiotherapy	11.5 0 ± 2.12	-	-

Table 1 shows variation by treatment type and gender in patients undergoing chemotherapy, radiotherapy and both

Table 2 Comparison of prolactin level of patients undergoing chemotherapy and radiotherapy

Study groups	Mean ± S.D. ng/ml	p-value
Chemotherapy [N=11]	11.9 ± 5.1	
Radiotherapy [N=18]	8.6 ± 6.2	0.308
Chemotherapy/radiotherapy	11.5 ± 2.12	

Table 2 shows that treatment types do not have significant effect on prolactin level

Table 3 Comparison of prolactin level of cancer patients and control subjects

Category	Mean ± S.D. ng/ml	p-value
Cancer patients	10.13 ± 5.5	0.002
Control [non cancer patients]	16.24 ± 7.6	

Table 3 shows the statistically significant association between prolactin levels and cancer

Table 4 Shows prolactin levels between cancer patients according to treatments

Study groups	Mean ± S.D. ng/ml Cancer patients	Mean ± S.D. [ng/ml] Control	p-value
Chemotherapy	11.9 ± 5.1	16.24 ± 7.6	0.08
Radiotherapy	8.6 ± 6.2	16.24 ± 7.6	0.003
Chemotherapy/radiotherapy	11.50 ± 2.12	16.24 ± 7.6	0.40

Table 4 shows significant reduction of prolactin level in patient undergoing radiotherapy but not chemotherapy or the combination

3.1. Results summary

The mean prolactin levels of cancer patients were lower than those of non-cancer controls. Among the treatment groups, radiotherapy patients exhibited the lowest mean prolactin concentration, followed by those on chemotherapy, and then combined chemo-radiotherapy. The differences among treatment groups were not statistically significant [$P > 0.05$]. However, the reduction in prolactin among all cancer patients compared with controls was significant [$P < 0.05$]. No significant difference was observed between male and female participants.

4. Discussion

Chemotherapy and radiotherapy are cornerstone treatments for cancer but often cause significant systemic and endocrine side effects. These therapies can induce oxidative stress, hormonal imbalances, and tissue damage, leading to complications such as hypopituitarism, altered prolactin levels, infertility, anemia, and fatigue. Radiotherapy involving the head and neck region particularly affects the hypothalamic-pituitary axis, while chemotherapy drugs may disrupt gonadal and adrenal function. Monitoring biochemical parameters helps assess organ function and guide supportive therapy during and after treatment.

In this study, Serum prolactin concentrations were compared with those of non-cancer control subjects. Prolactin levels were generally higher among cancer patients, although those undergoing radiotherapy exhibited lower mean prolactin concentrations compared to those receiving chemotherapy. No significant difference [$P > 0.05$] in prolactin levels among the different treatment groups, suggesting that treatment regimen may not significantly influence prolactin secretion. However, when cancer patients were compared to non-cancer controls, prolactin levels were significantly reduced [$P < 0.05$], indicating that the presence of cancer itself may suppress prolactin production. Radiotherapy patients had the lowest prolactin levels compared with chemotherapy and combined therapy groups. Gender showed no significant effect on prolactin concentration, implying that sex is not a major determinant of prolactin levels in this context.

The findings that serum prolactin levels are generally reduced in cancer patients compared to non-cancer controls, suggest that malignancy may suppress prolactin secretion. The observed lower prolactin levels in radiotherapy patients may indicate a stronger inhibitory effect of ionizing radiation on pituitary activity compared to chemotherapy. However, the absence of significant variation among the different treatment types suggests that treatment modality exerts a limited influence on prolactin regulation.

Previous studies have reported that circulating prolactin levels vary widely among cancer patients, depending on the tumor type and treatment exposure. Elevated prolactin has been observed in patients with non-small cell lung cancer and in some breast cancer cohorts, reflecting tumor-related endocrine alterations or stress-mediated secretion [16, 17]. In contrast, radiotherapy directed toward the head or neck region has been shown to induce hypothalamic–pituitary dysfunction, resulting in decreased prolactin production [18, 19]. These contrasting findings highlight prolactin's dual response: while tumor progression and systemic stress can elevate its secretion, exposure to ionizing radiation may damage pituitary lactotrophs or disrupt dopaminergic inhibition, leading to hormonal suppression.

The lack of significant gender-related differences in this study aligns with the observations of previous authors who reported that prolactin regulation in cancer is primarily influenced by disease and treatment rather than by sex [20]. Overall, the results suggest that radiotherapy exerts a more pronounced, though not statistically significant, suppressive effect on prolactin levels compared to chemotherapy. Recent reviews further emphasize prolactin's complex role in tumor biology acting both as a stress response hormone and as a growth factor depending on cellular context [21].

Overall, the findings indicate that while both chemotherapy and radiotherapy affect prolactin secretion, radiotherapy may have a more pronounced though not statistically significant suppressive effect.

The significant increase in serum prolactin levels observed among patients undergoing chemotherapy aligns with the previous demonstration that chemotherapy can stimulate prolactin secretion through stress-related pathways or damage to dopaminergic inhibitory neurons. Elevated prolactin may serve as a compensatory mechanism or reflect systemic stress response during cancer therapy. Prolactin has been implicated in tumor progression, angiogenesis, and immune modulation, suggesting that its regulation during treatment may influence therapeutic outcomes. Recent studies such as that by Li et al. [2020] [22] and Mendoza et al. [2023] [23] have also reported treatment-induced alterations in prolactin levels, reinforcing the relevance of this biomarker in monitoring cancer patients.

5. Conclusion

Cancer and its treatment may alter prolactin secretion, with radiotherapy showing the lowest prolactin levels among patients studied. However, treatment type and gender did not significantly affect prolactin levels. Monitoring endocrine parameters such as prolactin may be useful in assessing the physiological impact of cancer therapy among Nigerian patients. The observed hormonal changes highlight the need for periodic endocrine monitoring during cancer management to mitigate secondary physiological stress and potential complications associated with prolactin imbalance.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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