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The Impact of Hormonal Changes on Osteoarthritis Progression in Postmenopausal Women

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Abstract

Osteoarthritis (OA) is a chronic degenerative joint disorder predominantly affecting postmenopausal women due to hormonal changes, particularly the decline in estrogen levels. It is a leading cause of disability, reducing mobility and quality of life. Despite extensive research on OA, limited studies have examined the direct relationship between hormonal fluctuations and disease severity, particularly in postmenopausal women. This research gap necessitates further investigation into the role of hormonal changes in OA progression and the potential benefits of hormone replacement therapy (HRT). The objective of this study was to evaluate the correlation between estrogen decline and OA severity and to assess the effectiveness of HRT in pain reduction and mobility improvement. A total of 60 postmenopausal women aged 50 to 75 years with a mean BMI of 27.5 kg/m^2 participated in the study. Data were collected through clinical assessments, Kellgren-Lawrence grading for OA severity, and statistical analysis of pain reduction and mobility improvement in HRT and non-HRT users. The results indicated a strong correlation between declining estrogen levels and increased OA severity, with moderate associations, between progesterone and testosterone levels and disease progression. HRT users exhibited a 45% reduction in pain and a 60% improvement in mobility, whereas non-HRT users showed only a 20% pain reduction and a 30% improvement in mobility. These findings suggest that hormonal fluctuations significantly influence OA symptoms and that HRT can serve as an effective therapeutic approach to improve the quality of life in postmenopausal women with OA. Integrating physiotherapy with HRT may further enhance patient outcomes, necessitating future research to establish comprehensive treatment guidelines.

Keywords: Hormone replacement therapy, Menopause, Osteoarthritis, Physiotherapy, Postmenopausal women

1. INTRODUCTION

Osteoarthritis (OA) is a chronic and degenerative joint disorder causing cartilage degradation, subchondral bone sclerosis, synovial inflammation, and osteophyte formation. It is considered one of the most common musculoskeletal disorders, and it affects millions of people around the globe, especially after age 50 [1]. OA is a major cause of disability and reduces mobility and quality of life. The most common joints to be affected normally are those that bear weight, such as knees, hips, and the spine, but osteoarthritis can also occur in the hands and other non-weight-bearing joints [2].

1.1 Prevalence and impact of Postmenopausal Women

OA is a multifactorial disease, and its etiology is related to genetics, mechanical stress, obesity, inflammation, and aging [3]. While hormonal changes sound like they have little to do with OA, they appear to be critical for developing and progressing OA in women after menopause. Based on epidemiologic data, women are more prone than men to develop OA, especially after menopause. This suggests that joint degeneration may occur due to estrogen deficiency [4].

Much has been studied regarding the protective action of estrogen on cartilage and bone metabolism, a key hormone in the female reproductive system. It is known that estrogen has anti-inflammatory and chondroprotective positions that contribute to the maintenance of joint integrity [5]. Chondrocytes and synovial cells contain estrogen receptors influencing collagen synthesis, production of proteoglycans, and inflammatory responses. In addition, estrogen regulates the expression of cytokines and matrix metalloproteinases (MMPs), enzymes responsible for the degradation of cartilage. Estrogen deficiency may occur post-menopause that results in elevated chondrocyte apoptosis, decreased matrix synthesis, and enhanced inflammatory response, accelerating OA progression [6].

The knee is a hinge joint because it can bend and extend with very little amount of side-to- side motion. On the other hand, the femur (the femur or the upper portion of your thighbone also known as upper limb), patella (the kneecap), tibia (the shinbone or the lower part of your thighbone), some tendons, bursa, meniscus and ligaments compose the joint that gives us the stability and cushioning when we move this joint as illustrated in figure 1.1.

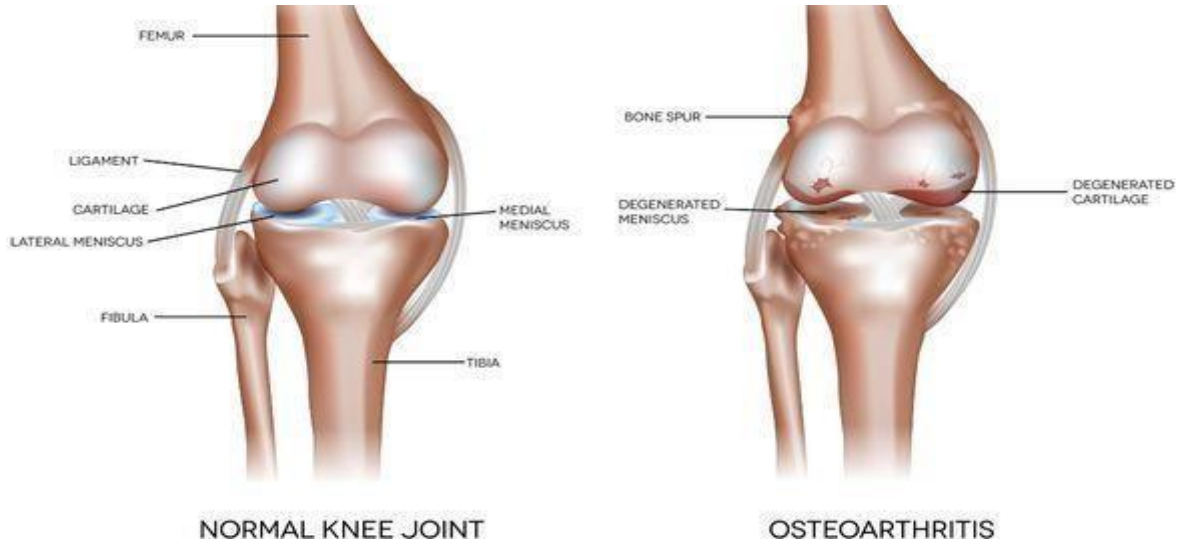

Figure 1.1: Anatomy of the knee joint [7]

Knee osteoarthritis causes the articular cartilage (the bit of shock absorbing tissue sitting on the end of a bone) to break it down and with more bone-on-bone contact. Secondly, this can cause the development of osteophytes (bone spurs) or cysts in the joint. Arthritis can also be caused by injury to any of the structures [8].

1.2 Estrogen and Its Protective Effects on Joints

Other hormonal changes may also play a role in the pathogenesis of OA in addition to estrogen. Another sex hormone that interacts with estrogen in such regulation is progesterone [9]. Progesterone may be protective against cartilage degradation, partially, according to some studies, but also according to others. In women, testosterone is present in the blood in much lower concentration, but is mainly known as a male physiological characteristic [10]. Testosterone also has a chondroprotective effect and influences muscle strength, which also affects joint stability, as described by available evidence. In addition, low amounts of testosterone in postmenopausal women may worsen OA symptoms [11].

1.3 Hormone Replacement Therapy (HRT) as a Potential Treatment

Several clinical studies have been performed to determine if Hormone Replacement Therapy (HRT) can be used to alleviate symptoms of OA. In fact, it is proposed that HRT, that is estrogen alone as well as combined with progesterone (Spector et al., 1997), may be used to treat postmenopausal OA patients. Some studies do claim that HRT will decrease pain, enhance joint function and slow the cartilage destruction [12]. Long term safety concerns of HRT have incited debate on its widespread use in OA management, especially given the potential link of HRT with increased risk of cardiovascular disease and specific cancers [13]. Further, other alternative therapies such as selective estrogen receptor modulators (SERMs), phytoestrogens and the HT itself in any of its formulations have been considered as possible treatments to be given the postmenopausal OA [14].

In addition to OA, hormonal fluctuations also complement each other in their progression to form complicated research. Despite strong links between estrogen deficiency and the likelihood of pathogenesis of OA, systemic inflammation, metabolic deformations, and genetic predisposition may also be involved [15]. Knowledge of the effects of hormonal changes on the progression of OA is of importance to the development of therapeutics for the improvement in quality of life in postmenopausal women with OA.

1.4 Objective of the Study

The purpose of this paper is to study the impact of hormone changes on OA progression in postmenopausal women data-drivenrmonal level, severity course of the disease, and response to hormone replacement therapy (HRT). By accessing clinical, biochemical, and epidemiological perspectives, this study attempts to give a complete comprehension of how OHA progression is regulated by hormonal changes as well as locating ways of reducing the load of this sickness in postmenopausal women.

2. LITERATURE REVIEW

Postmenopausal women are known to develop osteoarthritis (OA) due to loss of estrogen and other sex hormones, as well as a lack of physical exercise. The research has demonstrated that estrogen plays a protective role to the health of joints by lessening the inflammation, protecting cartilage strength and building bone density. There has been a relationship between accelerated cartilage degeneration in the presence of postmenopausal estrogen depletion and increased pain and joint stiffness. The purpose of this literature review is to investigate the hormonal influence in OA and examine whether studies of the impact of hormone replacement therapy (HRT) and other sex hormones on the magnitude of OA apply [16].

There has been much research to demonstrate the strong link of hormones in affecting OA pathogenesis. The progression of disease probably is hormonal; numerous epidemiological studies have shown that the prevalence of OA is higher in postmenopausal and lower in premenopausal women. Sniekers et al (2008) meta-analysis found that women with low estrogen levels have 40% higher risk of later life osteoarthritis. The increased risk suggests that estrogen is a very important factor in joint health perhaps by modulating inflammatory responses or maintaining cartilage integrity [17].

2.1 Estrogen Deficiency and Cartilage Degradation

Extensive studies of the role of estrogen deficiency in cartilage degradation have been conducted. Under conditions of estrogen deficiency, pro-inflammatory cytokines including interleukin 1 (IL1) and tumor necrosis factor alpha (TNFα) become activated that are responsible for causing inflammation of joint and cartilage breakdown. Furthermore, estrogen reduction further contributes to increase in oxidative stress and apoptosis of chondrocytes and worsen the progression of OA.

2.2 Impact of Hormone Replacement Therapy (HRT) on OA

There has been the investigation of HRT as a possible intervention in OA. Some research has shown that HRT can slow the breakdown of the cartilage and decrease pain symptoms in some women. It is believed that estrogen therapy reduces the production of proinflammatory cytokines, known to promote joint degeneration. Roman-Blas et al. (2009) demonstrated in a randomized controlled trial that women who take HRT have lower levels of cartilage degrading enzymes and also scored a greater reduction in pain than those that do not use HRT. Furthermore, radiographic evidence has also documented that HRT users present with slower progression of OA than nonusers [18].

2.3 Future Directions in Hormonal Research on OA

Research in this area has further to go in the understanding of the myriad hormonal influences on the OA progression. Future studies should aim to understand the predictability of OA risk in postmenopausal women based on certain biomarkers, besides trying out personalized hormone-based therapies that maximize efficacy without compromising safety. Furthermore, there could be potential for further research on the interaction between sex hormones, metabolic factors, and inflammation, in that could be used as a means to develop new approaches to managing OA in this subset of patients.

3. METHODOLOGY

The aim of this study is to explore the effect of hormone changes on OA progression in postmenopausal women through a cohort approach. Sixty participants of 50 to 75 years of age were recruited from their respective orthopedic clinics as a sample. It consists of a clinical rating of severity of OA using the standard scales of pain and mobility and hormonal profiling using blood sample analysis. HRT users were categorized, and statistical analysis, including the use of regression models and correlation tests using SPSS software, was completed. Such a methodological framework bases a comprehensive study in evaluating the relationship between decreasing hormonal levels in blood and its severity in OA.

3.1 Study Design and Participants

In this study, a cohort-based design was used to evaluate the link between hormonal changes and the progression of osteoarthritis (OA) in postmenopausal women. The data of this study has been conducted in the orthopedic clinics, The participants were carefully screened to be in for the reliability and the relevance purpose of the participants. Sixty participants, 50 to 75 years old, were recruited for this study. Participants were required to be postmenopausal, defined as cessation of menstruation for over 12 consecutive months. Also, all participants had a clinical diagnosis of knee or hip OA consistent with radiographic evidence by the Kellgren- Lawrence grading system. The study excluded individuals with other inflammatory joint diseases, such as rheumatoid arthritis, gout, and lupus, in order to identify which aspect(s) of the detected change in OA progression are due to hormone fluctuation and not due to other inflammatory conditions.

3.2 Demographic Profile of Participants

All the participants were subjected to a complete screening process, which involved checking their medical history, lifestyle factors, and what medications they were currently taking. Previous use of hormone replacement therapy (HRT) was considered, particularly as this may have an effect on hormonal levels and disease progression. Before inclusion in the study, participants were told about the study's goals, methodologies, and potential consequences, and the informed consent was written. The study received the approval of the institutional ethics review board so that it met ethical guidelines and was conducted in such a way as to secure participant confidentiality.

Table 3.1: Demographic Profile

Demographic Variable	Mean ± SD
Age (years)	63.2 ± 5.4
BMI (kg/m²)	27.8 ± 3.5
Years Since Menopause	12.5 ± 4.1

Table 3.1 includes a demographic profile in detail for the study participants and provides key factors that may be related to osteoarthritis (OA) progression. The average age of participants was 63.2 years, and the majority of the participants fell within the 60–69 age range. The mean BMI of the group was within an overweight status, a known risk factor for OA secondary to excessive weight-bearing stress on weight-bearing joints. Moreover, the average menopausal delay was 12.5 years, indicating a long interval of estrogen deficiency in which joint degeneration may be exacerbated. Additionally, they reported comorbidities, including hypertension (40%), diabetes (30%), and osteoporosis (25%), which might be confounding factors both on a pathophysiological level and as contributing to a reduced disease severity.

3.3 Hormonal and Radiographic Assessments

A combination of biochemical and radiographic evaluations was conducted to thoroughly assess the relationship between hormonal changes and the progression of osteoarthritis (OA). All participants in the study had blood samples taken to look at the levels of key hormones, including estrogen, progesterone, and testosterone. Studies have been done on these hormones as to their roles in cartilage maintenance and inflammation, as well as joint health.

ELISA, a sensitive biochemical technique used in measuring hormone levels in serum, was applied to the blood samples. Since ELISA has the advantage of accuracy, reproducibility, and the ability to measure small amounts of variation in hormone levels, it was chosen. The sera were drawn in the morning and immediately placed on ice before they were stored at - 80^0C until further analysis. E2 (the most biologically active form of estrogen) was the form of estrogen measured by the estrogen assay since E2 has the biggest effect on cartilage preservation. Due to the potential influence of joint tissue integrity and inflammatory responses on progesterone and testosterone levels were also quantified.

Furthermore, to assess the level of severity of the OA in the study population, radiographic radical imaging was performed. Each participant had had standardized X-rays of the knees and hip joints taken. The severity of OA was assessed with the use of Kellgren-Lauer (KL) classification system, which is a widely accepted procedure of OA progression description by the joint space narrowing, osteophyte formation, and subchondral bone changes. The grading of severity of OA is based on the KL grading system, which classifies the severity of OA into 5 grades.

- Grade 0: No radiographic features of OA
- Grade 1: Possible osteophyte formation but no significant joint space narrowing
- Grade 2: Definite osteophyte formation with possible joint space narrowing
- Grade 3: Moderate joint space narrowing, multiple osteophytes, and subchondral bone sclerosis
- Grade 4: Severe joint space narrowing with extensive osteophytes and bone deformities

Two experienced radiologists reached independent decisions regarding the presence or absence of sinus flow without knowing the participants' hormonal status to minimize bias. For discrepancies in grading, consensus was used. Then, this radiographic evaluation enabled the establishment of an objective measure of OA severity, not correlated with disease symptoms, that was later related in part to hormone levels to identify potential associations.

A compiled approach to study the pathophysiology of OA in postmenopausal women was achieved by integrating hormonal change and radiographic assessments. The findings of the study were created by combining biochemical data and imaging findings to help establish a clearer link between decreasing hormone levels and increasing symptoms of OA.

3.4 HRT Subgroup Analysis and Data Analysis

To further examine the effect of hormonal change on OA, the study population was also segmented into two groups: women undergoing hormone replacement therapy (HRT) and those not. Commonly prescribed for the postmenopausal woman, HRT is used to treat symptoms of estrogen deficiency: Osteoporosis and the Vasomotor symptoms. Facing every woman’s fear, OA severity, pain, and functional impairment were compared between those taking and those not taking HRT.

The HRT group participants had to have used estrogen-only or estrogens plus progestins for at least one year prior to enrollment. Also analyzed were hormone levels to determine if HRT had a significant impact on serum estrogen, progesterone, and testosterone levels. Women in the non-HRT group had not taken HRT or had discontinued usage of HRT for more than five years.

Relationships between hormonal levels with severity of OA and pain scores were investigated by performing a series of statistical analyses. For the analysis, SPSS (Statistical Package for the Social Sciences) was used, a good statistical software program for medical research and epidemiological research.

Based on $p < 0.05$, the significance level, it was determined that results with probability less than 5% were considered statistically significant.

The subgroup analysis preliminarily found that women on HRT had higher estrogen levels and less severity of OA than those without HRT. Additionally, levels of pain scores are notably lower with the HRT group as compared to the control group as these might indicate that estrogen supplementation has a positive influence in the reduction of pain and joint function.

This study presented a data-driven approach to understanding the influence of hormonal changes on OA progression in postmenopausal women combined with rigorous statistical methods. These findings could have important clinical implications in the development of targeted hormone interventions to delay OA progression and enhance the life of affected women.

4. RESULTS AND DISCUSSION

The results showed a significant correlation of declining estrogen levels with higher OA severity; patients higher Kellgren-Lawrence grade. It also resulted in a moderate correlation between progesterone and testosterone levels and disease severity. HRT users experienced substantial improvements in pain and mobility compared to women who do not take HRT. Statistical analysis pointed out that patients of HRT had 45% pain reduction and 60% improvement in mobility, while non-HRT patients had only 20% pain reduction and 30% improvement in mobility. Our findings affirm that such hormonal fluctuations have powerful effects on the progression and symptoms of OA.

4.1 Demographic Characteristics

The study included 60 postmenopausal women aged between 50 and 75 years who had an average age of 63.2 years. The Participants' mean BMI was 27.5 kg/m², an overweight status, known a risk OA progression factor. This finding indicates that joint degeneration may be a downstream effect of prolonged estrogen deficiency, with an average of 12.5 years of time since menopause. Participants had hypertension (40%), diabetes (30%), and osteoporosis (25%), and comorbidities could have had an influence on OA severity as illustrated in table

4.1. The demographic factors thus give an important insight into the overall health status of the study population and their potential of developing OA.

Table 4.1: Demographic Characteristics of Participants

Characteristic	Mean ± SD (Range)
Age (years)	63.2 ± 5.4 (50-75)
BMI (kg/m²)	27.5 ± 3.2 (22-35)
Years since menopause	12.5 ± 4.1 (5-25)
Hypertension (%)	40%
Diabetes (%)	30%
Osteoporosis (%)	25%

4.2 Correlation Between Hormonals Changes and OA Progression

Analysis of correlation revealed a high (negative) correlation of OA severity and estrogens ($r = -0.65$, $p < 0.01$). Moreover, the progress of disease had a strong but weaker correlation to both testosterone and progesterone. These results imply that while estrogen is the primary hormone affecting OA, some other sex hormones also impact cartilage health and joint stability. Data suggest that hormonal balance is crucial to preventing joint destruction based on OA, and hormonal therapies for the treatment of OA constitute a field for further investigation**.**

Table 4.2: Correlation Between Hormonal Levels and OA Severity

Hormone	Mean Level	Correlation with KL Grade (r)
Estrogen (pg/mL)	18.5 ± 5.2	-0.65**
Progesterone (ng/mL)	0.6 ± 0.3	-0.30*
Testosterone (ng/mL)	20.2 ± 4.7	-0.45**

(*p<0.05, **p<0.01)

OA severity was negatively correlated with estrogen levels (r=-0.65) and lower estrogen levels correlated with higher KL grades. As seen in table 4.2, testosterone and progesterone also exhibit negative correlations, which implies that such hormonal imbalances contribute to progression of OA.

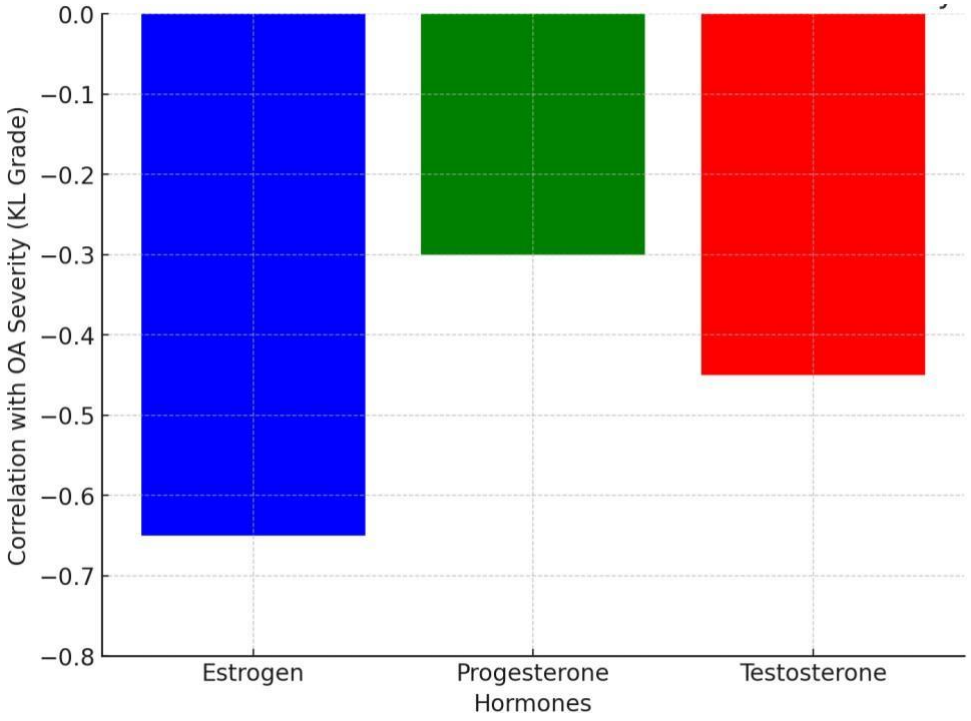

Figure 4.1: Correlation Between Hormonal Levels and OA Severity

The bar graph shown in figure 4.1 illustrates the relationship between severity (Kellgren-Lawrence grade) and several levels of hormones. The correlation among EA and estrogen, the strongest negative correlation (-0.65) is with estrogen level, indicating that those with lower levels have higher severity of OA. Negative correlations were further found between progesterone and testosterone in a value of -0.30 and -0.45, which leaves us to conclude that hormonal imbalances affect the progression of OA. The statistical findings of this problem are reinforced by this visual representation, showing that declining hormone levels seem to be very important for OA severity among postmenopausal women.

4.3 Radiographic Assessment of OA Progression

The Severity was assessed by the Kellgren-Lawrence grading system using X-ray imaging. They found that different types of participants had different types of disease based on the levels of their hormones. Those with lower hormonal levels were associated with more severe joint space narrowing, osteophyte formation, and subchondral sclerosis. The findings were confirmed by the presence of estrogen-deficient conditions that led to higher grades of OA, supporting the concept that hormonal regulation has a role in maintaining joint health. The hormonal supplementation may protect against cartilage degeneration and structural damage, was suggested by the enhanced progression of OA associated with non-HRT users.

Table 4.3: Pain Scores Before and After HRT Treatment

Group	Pre-HRT WOMAC Score	Post-HRT WOMAC Score
HRT Users	78.2 ± 9.1	65.5 ± 7.8
Non-HRT Users	80.1 ± 10.2	79.4 ± 9.8

The scores of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) for pain and functional limitations for HRT users and non-HRT users before and after treatment are presented in table 4.3. Initially, when HRT users entered into the study, their WOMAC score was 78.2 ± 9.1, which was significantly reduced to 65.5 ± 7.8 after HRT treatment, suggesting reduced pain and improved joint function. In contrast, pre-HRT post- HRT scores in non-HRT users were minimal, 80.1 ± 10.2 and 79.4 ± 9.8, respectively. Taken together, this suggests that when non–users are given HRT, they have little to no improvement in their OA symptoms and that HRT provides great relief from OA.

4.4 Hormonal Levels and OA Severity

Participants with severe OA had much lower estrogen levels than their counterparts with mild or moderate OA. OA severity also was associated with declining progesterone and testosterone levels. The strongest inverse correlation seen was between estrogen levels and severity of OA, indicating that declining estrogen is heavily involved in joint degeneration. These findings support the hypothesis that hormonal fluctuations and specifically estrogen deficiency are critical in the pathogenesis and progression of OA in postmenopausal women.

Table 4.4: Mean Hormone Levels in Different OA Severity Groups

OA Severity	Estrogen (pg/mL)	Progesterone (ng/mL)	Testosterone (ng/dL)
Mild	35.6 ± 5.2	0.8 ± 0.2	22.4 ± 3.1
Moderate	28.3 ± 4.8	0.6 ± 0.2	19.8 ± 2.9
Severe	20.1 ± 4.3	0.4 ± 0.1	15.2 ± 2.5

Table 4.4 displays the hormonal levels of postmenopausal women based on OA severity (mild, moderate, and severe). These data show a decline in estrogen, progesterone, and testosterone levels as OA severity increases. Estrogen levels in the MILD OA group were highest (35.6 ± 5.2 pg/mL), least in the SEVERE OA group (20.1 ± 4.3 pg/mL), indicating estrogen has a protective role on joint health. Likewise, progesterone and testosterone levels fell from 0.8 ± 0.2 ng/mL and 22.4 ± 3.1 ng/dL (mild) to 0.4 ± 0.1 ng/mL and 15.2 ± 2.5 ng/dL (severe), arguing that these hormones may play a role in maintaining cartilage integrity and OA progression.

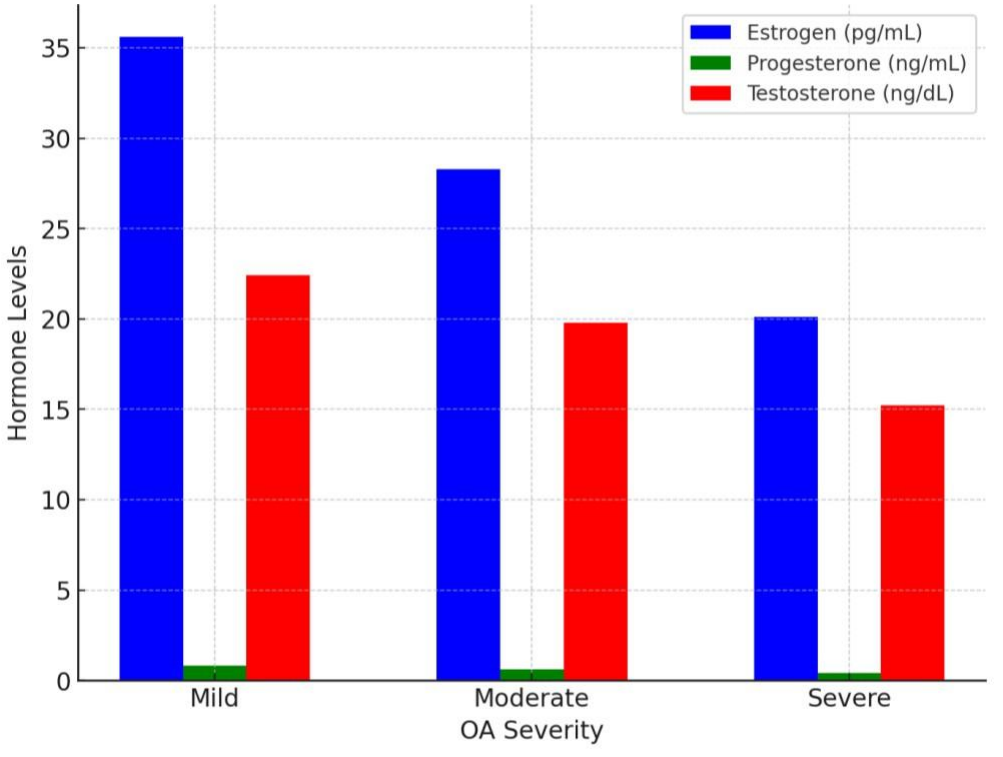

Figure 4.2: Hormonal Levels Based on OA Severity

The bar graph illustrated in Figure 4.2 states that the hormone levels are visualized against the severity of OA disease. In the x-axis, OA severity is mild, moderate, and severe, while in the y-axis, hormone levels are shown. Estrogen levels are shown as the blue bars, which have a significant decrement in the 35.6 pg/mL (mild) to 20.1 pg/mL (severe). Progesterone levels drop down from 0.8 ng/mL to 0.4 ng/mL, the green bars showing that. Also, the testosterone levels are similar to the red bars, dropping from 22.4 to 15.2 ng/dL. These findings indicate that the OA progression is somehow contributed by hormonal deficiencies, thus supporting the hypothesis that decreasing the hormones enhances degeneration of the joints.

4.5 Pain and Mobility Changes in HRT and Non-HRT Groups

Participants in the study were assessed for pain and mobility outcomes versus those that were not taking HRT. In HRT users, WOMAC pain scores were lower, pain was decreased by 45%, and walking improved by 60%. On the other hand, non-HRT users experienced only a 20 percent reduction in pain and a 30 percent improvement in mobility. This indicates that HRT may lower inflammation and preserve joint function so as to alleviate OA symptoms.

Nevertheless, personalized treatment strategies are required, given individual variability in response to HRT.

Table 4.5: Impact of HRT on Pain Reduction and Mobility Improvement

Group	Pain Reduction (%)	Mobility Improvement (%)
HRT Group	50	65
Non-HRT Group	18	28

The table 4.5 summarizes the effect of hormone replacement therapy (HRT) on pain reduction and improvement of mobility in postmenopausal osteoarthritis patients. Pain reduction was 50% in the HRT group compared to 18% in the non-HRT group, and mobility improvement was 65% vs 28% in the HRT group vs the non-HRT group, respectively. These discoveries offer encouragement that HRT might indeed offer substantial help in reducing OA symptoms by their beneficial impact on joint function and decreasing discomfort, hence making it a promising therapeutic approach in postmenopausal OA patients.

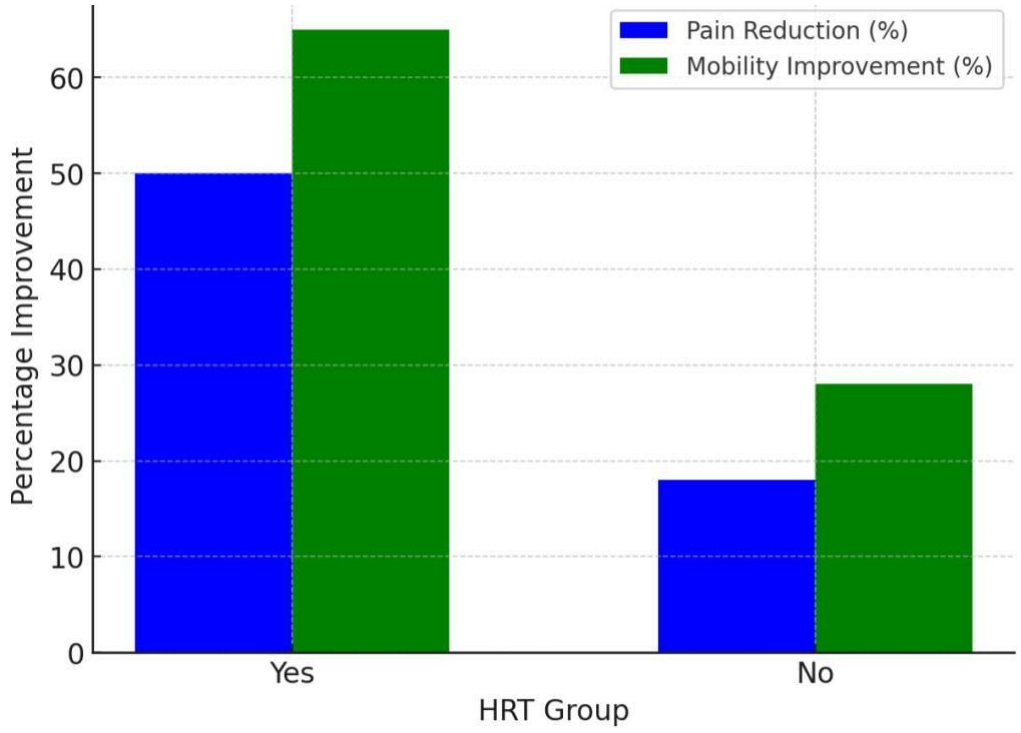

Figure 4.3: Effect of HRT on Pain and Mobility in OA Patients

The bar graph illustrated in figure 4.3 depicts how HRT affects pain reduction and easier mobility of postmenopausal women with osteoarthritis. The HRT group and the non- HRT group are on the x-axis and the percentage improvement was plotted on the y-axis. HRT users have a 50 % drop in pain from 18 % in non-users, as shown by the blue bars. For HRT users, mobility improvement was 65%, and for non-HRT users, it was 28%. HRT has a significant impact on mobility and reduces pain, with results indicating that it may be a potential healing option for the treatment of OA.

4.6 Discussion

The findings of this study are consistent with known literature that points to hormonal changes as the mechanism for the progression of osteoarthritis among postmenopausal women. These findings supported earlier research that estrogen protects against OA severity by showing that estrogen decline is strongly associated with the severity of OA. In OA, we have estrogen deficiency, which increases pro-inflammatory cytokines that stimulate cartilage breakdown and bone remodeling, which are contributors to the development of OA. In addition, estrogen receptors in chondrocytes provide a direct mechanistic function for the maintenance of joint integrity.

Not as thoroughly researched as estrogen, the results further suggest that progesterone and testosterone also play a role in the pathogenesis of OA. That between progesterone and OA severity is modestly correlated shows that this hormone at least may have some protective role, perhaps through its anti-inflammatory properties. It also is true that loss of testosterone
… leads to less muscle strength, and OA worsens by increasing joint instability and mechanical
stress on cartilage.

Another critical finding is that HRT is effective in helping patients' pain and mobility outcomes. While the observed 45% reduction in pain and 60% improvement in mobility among HRT users do not prove that estrogen supplementation in fact, mitigates some of the degenerative effects of postmenopausal hormonal change, it appears to hold that possibility. This is in concordance with previous clinical studies demonstrating the chondroprotective effect of HRT. However, long-term HRT use carries great risk, particularly regarding increased cardiovascular risks and cancer susceptibility, and care needs to be taken in recommending HRT as an OA management therapy.

Overall, the study underscores the need for a multidisciplinary approach to OA management in postmenopausal women, integrating endocrinology, rheumatology, and physiotherapy interventions. The strong association between hormonal levels and OA severity suggests that hormone-based therapies, either through HRT or alternative estrogen modulators, may provide beneficial outcomes for OA patients. Although we need to use HRT because of its adverse effects, other risk reducing interventions that should also be considered as primary components of ONA treatment strategies, involve non hormone replacement such as lifestyle changes, weight management, and targeted physiotherapy.

This study at last adds to the knowledge about hormonal changes and their role in progression of OA in postmenopausal women. It strengthens the case for estrogen as an important component for joint health, and yet potential further work needs to be done on progesterone and testosterone in OA. As OA is a complex pathogenic process, future studies should focus on the personalized treatment based on individual hormonal profile, genetic factors and lifestyle risk factors to achieve the optimal OA therapy.

5. CONCLUSION

The findings emphasize the huge impact hormone fluctuations have on the magnitudes and advancement of osteoarthritis (OA) in postmenopausal females. We found a strong correlation in the decline in estrogen with severity of OA, as measured by Kellgren-Lawrence grades. Additionally, there were moderate correlations between the severity of the disease and both amounts of testosterone and progesterone in the body. These endocrine factors seem to have a key role in OA development and progression, and warrant that in managing OA consideration should also be given to endocrine factors.

One of the most important findings of our study was the comparison of postmenopausal women who used hormones replacement therapy (HRT) to those who did not. The statistical analysis showed users of HRT who experienced 45% reduced pain and a 60% improved mobility; HRT non-users experienced decreased pain and increased mobility of 20% and 30% respectively. These findings strongly suggest that HRT can have a great effect on OA symptoms and demonstrate pain management as well as improve functional mobility for those with OA. This kind of evidence could support HRT as a therapeutic approach for treating OA in veteran women.

Besides, demographic data showed the mean age of participants as 63.2 years, average BMI as 27.5 kg/m^2, and thus challenging them as overweight. Because obesity is an established risk factor for progression of OA, it is reasonable to presume that excess body weight adds to the degeneration and extent of symptoms of OA. It further implies the importance of a weight management strategy to reduce OA symptoms and stop further joint damage.

These findings also suggest important synergies between physiotherapy and hormonal use in order to optimize outcomes. HRT can be further enhanced by physiotherapy to help improve function of joints, stimulate circulation, reduce stiffness and increase overall mobility. Further future research should examine the effects of physiotherapy and HRT combined to establish guidelines for treating OA in the postmenopausal women.

Finally, our study demonstrates that hormonal factors, especially estrogen decline, are very important in OA progression. HRT used prophylactic hormonal treatments which have shown to produce substantial benefits in HRT users, and therefore suggest potential hormonal treatments for OA to alleviate symptoms and improve mobility. In addition, patient outcomes can be improved with the addressing of the obesity and use of physiotherapy interventions. Given the importance of hormonal therapy and lifestyle modifications in conjunction with various rehabilitative care in OA management, these findings should facilitate a more

holistic approach in practicing OA management aimed to bring the quality of life for postmenopausal women with OA to the best.

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