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An Investigation into Etiology, Nutritional Preventative Strategies and an Innovative Design of a Knee Brace for Knee Ligament Injuries Among Women Aged 45 And Above Presenting with Knee Pain in Kenya

Nicholas Kinoti[1], Nicole Wafula[2], Prof. Daniel Ojuka[3]

[1,2] Bachelor of Medicine and Bachelor of Surgery,
University of Nairobi, Department of Surgery
[3] MBChB, MMed, General Surgery (UoN) PGH, FCG, FCS, PhD (UoN), Consultant Breast and General Surgeon, Chairman, Department of Surgery, University of Nairobi

Abstract

Background:

Knee pain among postmenopausal women in Kenya is frequently misattributed to osteoarthritis, leading to suboptimal management. This study investigates the biomechanical and hormonal etiology of medial collateral ligament (MCL) injuries in women aged ≥45, emphasizing estrogen deficiency and angular misalignment as causative factors.

Methodology:

A Literature review analysis of published papers revealed that an android pelvis shape in men results in a bigger neck shaft angle which correlates anatomically with a smaller quadriceps angle, while for females it is gynecoid shaped pelvis results in a larger quadriceps angle therefore this research aims at explaining how the Q angle, the Neurofascial angle and Neurofascial, will create a biomechanical interplay which results in MCL tension hence causing chronic knee pain in women over 45 years who will be our subjects. This will be done through a cross-sectional analysis angle. Angular measurements (Q angle, Neurofascial Strain [NFS] angle, and Femoral Neck-Shaft angle) will be analyzed alongside clinical histories, hormonal profiles, and nutritional patterns. Radiological and biomechanical screening complemented clinical assessments. Statistical significance will be assessed via chi-square analysis.

Expected Outcomes and Significance:

We anticipate identifying a significant subset of women with ligamentous pathology misclassified as osteoarthritis. The study will clarify estrogen's role in ligament degradation and propose non-hormonal

interventions such as antioxidant supplementation and ergonomic corrections to mitigate injury risk without increasing breast cancer susceptibility.

This research will challenge prevailing diagnostic assumptions, promote personalized screening protocols, and inform safer, targeted interventions for postmenopausal knee pain. It aligns with Kenya's public health goals by advocating for evidence-based, non-invasive strategies that empower aging women and reduce long-term disability.

Innovation:

The study introduces the NFS angle as a novel diagnostic and screening tool for assessing medial knee strain and proposes a custom-designed MCL-supporting knee brace tailored to pelvic-femoral morphologies. Additionally, vitamin C supplementation is advocated as a safer alternative to hormone replacement, offering antioxidant protection and enhanced collagen synthesis without oncogenic risks.

Conclusion:

Irregular biomechanical alignment and hormonal decline in postmenopausal women synergistically predispose the MCL to microtears and chronic pain. Integration of angular metrics with targeted nutritional and orthopedic interventions presents a promising paradigm shift from conventional osteoarthritis-centric management. The adoption of vitamin C and brace-based therapy may offer sustainable, cancer-free relief for this underserved population.

1. Introduction

A significant number of women aged 45 and above who present to health facilities with generalized bone pain are often presumptively diagnosed with osteoarthritis. While this diagnosis may be appropriate in many cases, it is not universally accurate. The term “misdiagnosis” here does not necessarily imply error, but rather reflects a limitation in differentiating osteoarthritic pain from other potential causes.

In postmenopausal women, declining estrogen levels are a well-documented physiological change. Estrogen plays a crucial role in bone health through its influence on calcium absorption and vitamin D metabolism, which collectively regulate bone mineralization. As estrogen levels drop, many women experience widespread bone discomfort and are consequently placed on mineral supplementation typically calcium and vitamin D and in select cases, prescribed hormone replacement therapy (HRT).

While such interventions may alleviate generalized bone pain, clinical observations reveal that knee pain in these patients tends to persist, albeit with reduced intensity. This residual discomfort is indicative of a more localized pathology, often involving ligamentous injury rather than purely metabolic bone disease. Thus, attributing knee pain solely to estrogen deficiency and osteoarthritis may overlook underlying biomechanical contributors, such as ligament stress or damage.

1.1 Research Question

What is the role of post-menopausal estrogen deficiency and biomechanical alignment in the etiology of medial knee ligament injuries among women aged 45 and above presenting with chronic knee pain in Kenya and how would Vitamin C supplementation and a knee brace innovation help alleviate this problem?

1.2 Background

The purpose of this study is to investigate the underlying causes and biomechanical contributors to knee ligament injuries particularly the medial collateral ligament strain among women aged 45 and above presenting with chronic knee pain in Kenya by examining the relationship between postmenopausal estrogen deficiency and anatomical alignment (including Q angle, the Neurofascial angle and Femoral neck shaft angle) and ligament physiology. The study aims at differentiating Osteoarthritic pain from a combination of osteoarthritic pain and ligamentous tear as Osteoarthritis causes diffuse pain and treatment of osteoarthritis alone in a patient with a combination of osteoarthritis and ligamentous tear causes persistence of the pain in the knee due to ligament tear. The study also aims to bring out the aspects of prevention and alleviation of Medial collateral ligament tear by use of vitamin C supplementation and a knee brace innovation.

1.3 Hypothesis

This research suggests that a combination of post-menopausal estrogen deficiency and changes in biomechanics of the knee and hip with advancement of age in women causes predisposition of the medial collateral ligament to microtears and injury and that Vitamin C supplementation and an innovation of a knee brace that focuses on supporting the Medial collateral ligament would help in alleviating this pain in the population.

Significance of the research: unlike the existing therapies such as hormone replacement therapy, the forms of intervention for this condition as suggested by our study are less likely to predispose the patients to breast cancer and other cancers which are leading causes of oncologic death among women in Kenya.

2. Literature Review

2.1 Overview of knee pain in postmenopausal women

Published studies have shown postmenopausal women have a decrease in estrogen levels hence diagnosed with osteoarthritis which is diffuse bone pain and most of them are managed with calcium and vitamin D supplementation, this causes recovery from pain in all joints apart from the knee joint which has its pain caused by ligament tear rather than degenerative pathology. This misattribution of osteoarthritis diagnosis may delay proper care being administered to these women.

2.2 Estrogen role in ligament physiology

Estrogen has effect on the ligament integrity and physiology: Ligaments are made of dense regular connective tissue, mainly type I collagen, and some elastin, fibroblasts, and ground substance (proteoglycans + Glycosaminoglycans)
The role of estrogen and how it affects ligaments is:

1. **Collagen remodeling** - **Estrogen Decreases Collagen Synthesis**, by suppressing type I collagen gene expression (COL1A1), reducing activity of fibroblasts leading to reduction in tensile strength of collagen due to the weaker collagen fibril structure.
   Estrogen also Increases Matrix Metalloproteinases specifically MMP-1, 2 and 9 which lead to collagen breakdown in ligaments.
   Estrogen also reduces lysis oxidase (LOX) activity. Lysyl Oxidase is responsible for crosslinking collagen fibres to increase strength of the ligament. Low LOX activity causes decreased collagen cross linking and decreased tensile strength.
2. **Water and Proteoglycan Content of ligament is affected by estrogen;** Estrogen increases proteoglycan synthesis which causes an increase in attraction of water to the ligament making it more extensible
3. **Increased elastin to collagen ratio:** Studies shows that estrogen increases the elastin to collagen ratio, since elastin is more stretchable, it contributes to ligament laxity

2.3 Cellular mechanism of estrogen and its effects on ligament fibroblasts

Estrogen receptor Alpha and Beta activation lead to decreased collagen production, increased Matrix Metalloproteinase expression and changes in cytoskeletal organization making the cells more prone to deformation.

2.4 Clinical scenarios where estrogen induced ligament laxity occurs

Ligament laxity, also known as joint hypermobility or being "double-jointed," refers to ligaments that are looser than normal, allowing for greater range of motion in the joints.

1. Menstrual Cycle - Estrogen peaks in the follicular phase (mid-cycle) this is associated with increased joint laxity. Explains why ACL injuries are more common in women mid-cycle.
2. Pregnancy - Estrogen and relaxin cause pelvic ligament softening to allow for delivery. This may also affect knees, spine and wrists
3. Oral contraceptive use - Synthetic estrogens can modulate collagen turnover. Effects vary based on dose and duration
4. Menopause - Drop in estrogen causes loss of ligament elasticity, stiffness and increased risk of injury, due to reduction in water content in the ligament as estrogen is essential for water content in the ligament.

2.5 Estrogen effect on bone

Bone is constantly remodeled through two main cells: Osteoclasts responsible for breaking down bone. Osteoblasts are responsible for building new bone.

This process is tightly regulated by hormones, including estrogen, parathyroid hormone (PTH), vitamin D, and calcitonin.
Estrogen plays a critical role by: Inhibiting osteoclast genesis (formation of osteoclasts) Promoting osteoclast apoptosis (programmed cell death) Increasing osteoprotegerin (OPG)activity, which acts as a decoy receptor to block bone resorption.
Estrogen also suppresses RANKL which is essential for osteoclast activation, promotes osteoclasts apoptosis and reduces the activity of IL-1, IL-6 and TNF alpha.
What Happens When Estrogen Drops? (e.g. Menopause) After menopause, Estrogen levels fall sharply, RANKL increases, OPG decreases causing increase in osteoclast activity, Bone resorption exceeds formation resulting in net bone loss.
Estrogen deficiency leads to an increase in both the number and activity of osteoclasts, accelerating bone resorption and leading to osteoporosis.
Up to 20% of bone mass is lost in the first 5–7 years after menopause due to estrogen deficiency

Characteristics

1. Trabecular bone loss > cortical (e.g., vertebrae, femoral neck, distal radius)
2. Increased fracture risk (hip, spine, wrist)
3. Often silent until a fracture occurs

How hormone replacement therapy is involved in development of breast cancer

Breast cancer is the most prevalent malignancy among Kenyan women accounting to approximately 23% of all cancers. Estrogen receptor (ER) positivity is common making hormonal dynamics a critical factor in disease progression and recurrence. Hormone replacement therapy especially combined estrogen-progestin regimens has been linked to increased breast cancer risk through several mechanisms: Estrogen stimulation of ER-positive cells: Promotes proliferation of breast epithelial cells, increasing mutation risk. Progestin synergy: Enhances estrogen's mitogenic effects, particularly in lobular and ductal tissues. Increased breast density: HRT raises mammographic density, which is both a risk factor and a diagnostic challenge.

3. Research Objectives

This research is aimed at addressing the purpose of this study is to investigate the underlying causes and biomechanical contributors to knee ligament injuries particularly the medial collateral ligament strain among women aged 45 and above presenting with chronic knee pain in Kenya by examining the relationship between postmenopausal estrogen deficiency and anatomical alignment (including Q angle, the Neurofascial angle and Femoral neck shaft angle) and ligament physiology.

3.1 Broad objectives

- To investigate the etiology of medial knee ligament injuries in women aged 45 and above, considering hormonal changes, particularly estrogen deficiency.

- To explore the biomechanical implications of pelvic and femoral morphology on ligament stress and injury risk in aging females.
- To assess the diagnostic limitations of osteoarthritis presumptions and identify overlooked ligamentous pathologies using clinical, radiological, and biomechanical data.
- To propose safer, non-hormonal preventive strategies like vitamin C supplementation and ergonomic adjustments to mitigate ligament degradation without increasing cancer risk.

3.2 Specific aims

- Characterize the biomechanical stress patterns (Q-angle, NFS angle, femoral neck-shaft angle) that predispose women to medial collateral ligament (MCL) injuries.
- Correlate hormonal levels (estrogen, vitamin D) with ligament structural integrity and injury prevalence.
- Evaluate the efficacy of current interventions (vitamin D, hormonal contraceptives) in managing persistent knee pain.
- Analyze the role of estrogen in collagen remodeling and ligament laxity, including cellular mechanisms like fibroblast behavior and MMP activity.
- Determine the diagnostic accuracy of clinical assumptions, particularly differentiating osteoarthritic pain from ligament-specific pathology.
- Quantify ligament vulnerability and propose preventive solutions like antioxidant supplementation (vitamin C), ergonomic corrections, and targeted physiotherapy.
- Compare individual patient data (trauma history, reproductive factors, nutritional habits) to establish personalized risk profiles and guide future screening tools.

4. Research Methodology

Having established this, it is evident that the study population is women aged 45 years and older experiencing chronic knee pain unresponsive to conventional bone mineral supplementation.

The inclusion criteria are therefore narrowed down to:

1. Individuals with a history of trauma or repetitive stress activities consistent with mechanisms of ligament injury.
2. Patients undergoing vitamin D supplementation with persistent knee pain.
3. Absence of other metabolic conditions that may hinder vitamin D uptake or utilization.

Knee ligament injuries commonly result from:

- Sudden twisting or pivoting movements (as seen in athletics),
- Direct blows to the knee,
- Repetitive varus or valgus stresses.

Specific ligament mechanisms:

- Anterior Cruciate Ligament (ACL): Injuries typically arise from abrupt changes in direction while the foot remains planted, leading to overextension.
- Posterior Cruciate Ligament (PCL): Damage is often due to direct trauma to the anterior aspect of the knee.
- Lateral Collateral Ligament (LCL): Associated with varus stress, which occurs in individuals with a bow-legged gait.

Of particular relevance to this study is the MCL, given its susceptibility in postmenopausal women. Anatomical differences between male and female pelvis and femur morphology contribute significantly to this vulnerability.

- Women typically possess a gynecoid pelvis, which features a wider pelvic inlet and outlet conducive to vaginal delivery. This broader pelvic structure results in a larger femoral neck-shaft angle.
- The femoral articulation with the acetabulum, combined with a wider pelvis, results in a genu valgus (knock-kneed) alignment.
- Genu valgus places chronic valgus stress on the MCL, predisposing it to injury over time.

This biomechanical predisposition is amplified during developmental milestones:

- Puberty, when pelvic widening accelerates.
- Postmenopausal, when reduced estrogen impairs vitamin D-mediated mineralization, further weakening ligamentous and bony structures.

4.1. Study Design

- Type: Descriptive cross-sectional study with an analytical component.
- Purpose: To evaluate the prevalence of medial ligament stress and its contribution to chronic knee pain among postmenopausal women with persistent symptoms despite vitamin D supplementation.

4.2. Study Population

- Target Group: Women aged ≥45 years presenting with chronic knee pain.
- Sample Size: Determined using prevalence data and a confidence interval of 95%

4.3. Inclusion Criteria

- History of repetitive knee stress or trauma linked to ligament injury.
- Currently or previously on vitamin D supplementation with continued knee pain.
- No comorbid metabolic conditions (e.g., renal dysfunction, malabsorption syndromes) interfering with mineral uptake.

4.4. Exclusion Criteria

- Diagnosed rheumatoid arthritis, osteoporosis, or other systemic autoimmune conditions.

- Previous knee surgeries or orthopedic implants.
- Current use of corticosteroids or medications that alter bone density independently.

4.5. Data Collection Techniques

- Clinical Assessment: Structured history and physical exam focusing on mechanical stress markers, knee alignment (genu valgus), and ligament tenderness.
- Radiological Evaluation: MRI or ultrasound to assess ligament integrity, particularly the medial collateral ligament.
- Hormonal Panel: Serum estrogen and vitamin D levels.
- Biomechanical Screening: Evaluation of femur-pelvis angle using imaging and anthropometry.

4.6 How the Quadriceps angle is measured using a goniometer

1. **Patient Positioning:**

Have the patient lie supine (on their back) with their legs extended and knees fully straight. The quadriceps muscle should be relaxed.

2. **Landmark Identification:**

    - **ASIS:** Locate the ASIS, which is the bony prominence at the front of the hip.
    - **Patellar Center:** Identify the midpoint of the patella (kneecap).
    - **Tibial Tuberosity:** Find the tibial tuberosity, the bony bump on the front of the tibia (shin bone), just below the kneecap.

3. **Goniometer Placement:**

    - **Fulcrum:** Place the center point (fulcrum) of the goniometer directly over the midpoint of the patella.
    - **Proximal Arm:** Align the stationary arm of the goniometer with the ASIS.
    - **Distal Arm:** Align the moving arm of the goniometer with the tibial tuberosity.

4. **Measurement:**

Read the angle formed between the two arms of the goniometer. This is the Q-angle.

4.7 How to measure NFS angle using a goniometer

1. Patient Positioning and Stabilization:

- **Position:**

The patient should be positioned comfortably, typically lying supine (on their back) for knee extension measurement or sitting with the thigh supported for flexion.

- **Stabilization:**

The thigh and lower leg should be stabilized to prevent unwanted movement during the measurement.

2. Goniometer Placement:

- **Fulcrum:**

The goniometer's fulcrum (the pivot point) is placed over the lateral epicondyle of the femur, which is a bony prominence on the side of the knee.

- **Arms:**

One arm of the goniometer is aligned with the midline of the femur (thigh bone), and the other arm is aligned with the midline of the fibula (lower leg bone).

3. Measuring Knee Extension:

- **Passive ROM:**

For knee extension, the examiner may stabilize the distal femur, reach under the ankle, and apply overpressure, ensuring the knee is free of rotation.

- **Alignment:**

The goniometer's stationary arm should align with the femur, while the moving arm aligns with the fibula as the knee is extended.

4. Measuring Knee Flexion:

- **Passive ROM:** For knee flexion, the patient may be asked to bend their knee, and the goniometer is aligned in a similar manner, with the stationary arm on the femur and the moving arm on the fibula.

5. Reading and Recording:

- **Read:**

After proper alignment, the angle is read directly from the goniometer scale.

- **Record:**

The measurement is recorded in degrees, noting whether it is knee extension (0 degrees is typically full extension) or flexion

4.8 Steps of measuring neck shaft angle using radiograph

1. **Obtain a standardized radiograph:**

The patient should be positioned with the leg in a neutral position and the patella (kneecap) facing forward.

2. **Identify the femoral head center:**

Locate the center of the femoral head on the radiograph.

3. **Draw the neck axis:**

Draw a line connecting the femoral head center to the midpoint of the narrowest part of the femoral neck.

4. **Draw the shaft axis:**

Draw a line along the long axis of the femoral shaft, typically by identifying midpoints at the upper and lower ends of the shaft.

5. **Measure the angle:**

Use a goniometer or similar tool to measure the angle between the neck axis and the shaft axis.

6. **Consider the method:**

Different methods exist, some using circles to define the neck axis, while others rely on visual best-fit lines.

7. **Reference values:**

The normal NSA in adults is approximately 126-135 degrees. Variations may exist based on age, sex, and ethnicity

4.9 Correlation of NFS angle and MCL tensions

The neurofascial strain angle is also known as the anatomic tibio-femoral angle as it represents:

1. It quantifies the medial deviation of the femur relative to the vertical axis of the tibia in the frontal plane
2. The angle reflects the valgus alignment of the knee, where the femur angles inwards towards the midline. It is measured by drawing the anatomic axis of the femur and the anatomic axis of the tibia and the angle formed between the two lines is the NFS angle. Typically, it ranges between 5 to 10 degrees in healthy adults. A higher angle may indicate genu valgum

4.10 Estimated sample size

1. Number of women aged 45 years and above – 35 to be used as the research subjects
2. Number of women aged below 45 years – 20 to be used as the control group
3. Number of men – 10 to be used to rule out gender bias

4.11 Conceptual framework

We intend to collect the data in a period of 14 days at Kenyatta National Hospital

Day 1 – Ward 6A
Day 2 – Ward 6C
Day 3 – Ward 6D
Day 4 – Ward 5A
Day 5 – Ward 5B
Day 6 – ward 5C
Day 7 – Ward 5D
Day 8 – Ward 1B
Day 9 – Ward 7A
Day 10 – Ward 7B
Day 11 – Ward 7C
Day 12 – Ward 7D
Day 13 – Physiotherapy department
Day 14 – Orthopedic Clinic

4.12 Data analysis procedure

Proving the correlation between

- Smaller NSA angle and knee pain using a bar graph
- Larger Q angle and knee pain using chi square analysis
- Larger NFS angle and knee pain using a bar graph

4.13 Workplan

Research proposal and ethical approval – 4 days

Conceptual framework – 14 days of data collection

Data analysis – 3 days

Report writing and research paper compilation – 5 days

5. RESULTS

Data was collected, compiled and analyzed from subjects and control group and conclusions drawn from them.

5.1 Study of Correlation of Q Angle and MCL Tension

	Regular Q angle	Irregular Q angle	Total
>= 45 years age	1	10	11
< 45 years age	15	6	21
Total	**16**	**16**	**32**

Table 1: Q angle measured using upper limit of normal (12 to 19)

	Regular Q angle	Irregular Q angle	Total
>= 45 years age	5.5	5.5	11
< 45 years age	10.5	10.5	21
Total	**16**	**16**	**32**

Table 2: Observed values of Q angle measured using upper limit of normal (12 to 19)

	Observed	Expected	O-E	(O-E)2	(O-E)2/E
>= 45 years age with Regular Q angle	1	5.5	-4.5	20.25	3.6818
>= 45 years age with irregular Q angle	10	5.5	4.5	20.25	3.6818
< 45 years age with regular Q angle	15	10.5	4.5	20.25	1.9286
< 45 years age with irregular Q angle	6	10.5	-4.5	20.25	1.9286

Table 3: Table for calculation of Chi square

CHI SQUARE STATISTICS:
3.6818 + 3.6818 +1.9286 + 1.9286 = 13.0116
DEGREES OF FREEDOM
(2-1)*(2-1)=1
CRITICAL VALUE
P=0.05 while CHI2 is 13.0116 with a degree of freedom of 1
13.0116 is more than 3.841

We neglect the null hypothesis: There is a highly significant association between irregular Q angle in postmenopausal women with chronic knee pain and increased MCL tension ($p < 0.05$). This indicates that irregular Q angle in postmenopausal women with chronic knee pain is strongly linked to an increased likelihood of developing MCL tension in this context.

5.2 Study of Correlation of Neurofascial Strain Angle and Mcl Tension

The neurofascial strain angle is also known as the anatomic tibio-femoral angle as it represents:

1. It quantifies the medial deviation of the femur relative to the vertical axis of the tibia in the frontal plane
2. The angle reflects the valgus alignment of the knee, where the femur angles inwards towards the midline. It is measured by drawing the anatomic axis of the femur and the anatomic axis of the tibia and the angle formed between the two lines is the NFS angle. Typically, it ranges between 5 to 10 degrees in healthy adults. A higher angle may indicate genu valgum

Female patients

Table 4: Neurofascial strain angle values in women

Age	NFS angle		Fruit intake
	Left	Right	
22	30		Occasional
25	24	26	Occasional
25	48		Rare
26	25	25	Occasional
28	45	45	Occasional
29	35	30	Occasional
30		47	Occasional
30	40	40	Rare
35	45	40	Rare
36	56	40	Rare
37	35	40	Rare
37	50		None
39	25	25	None
43	38	35	Occasional
43	30	40	Rare
44	30	18	Occasional
47		45	Rare
48	40	60	Rare
52	70	50	Rare
52	48	45	Occasional
53	70	40	None

60	70		None
64	12		High
64		65	Rare
65	50	60	High

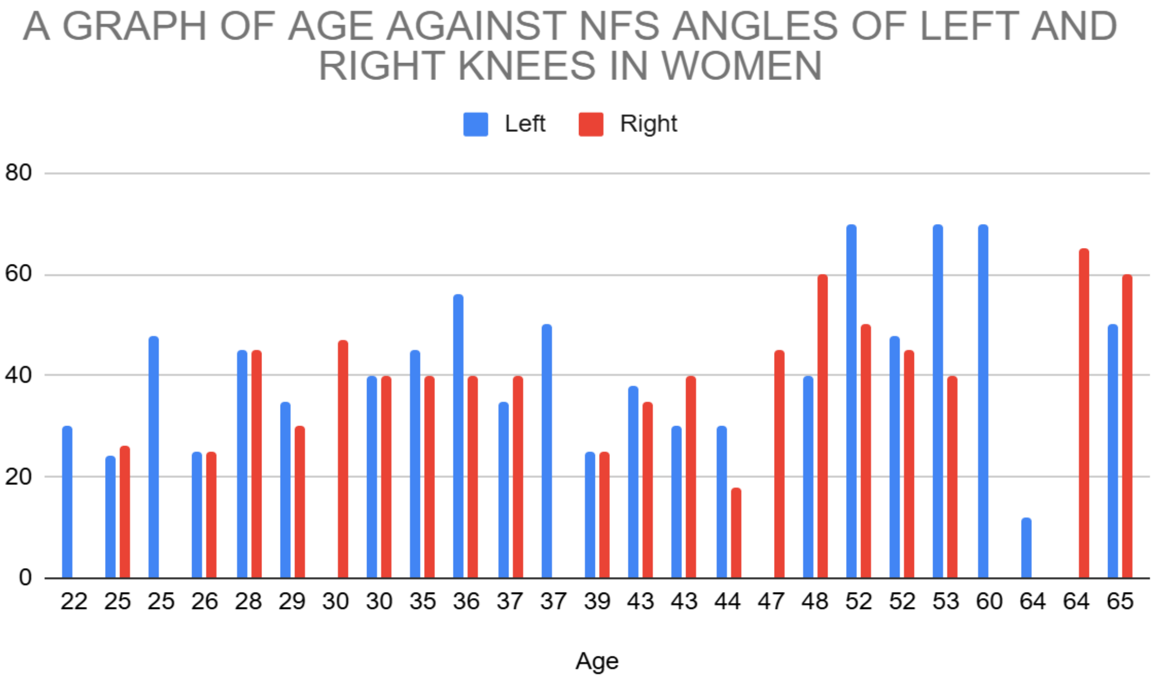

Figure 1: Relation of NFS angle in women with advancement of age and depletion of estrogen

This chart shows an increase in Neurofascial strain angle in women with advancement of age and depletion of estrogen causing increased MCL tension. Outliers are mainly due to high intake of fruits which supports the study's hypothesis that vitamin C is useful in mitigating MCL tension.

Male patients

Age	NFS angle		Fruit intake
	Left	Right	
19	25	20	rare
20	30	10	High
25	22	30	high
25		20	Rare
26	20	22	Occasional
30	30	30	Rare
31	22	22	occasional
38	10	15	Occasional
40	10	15	Rare

Table 5: Neuro fascial strain angle in men

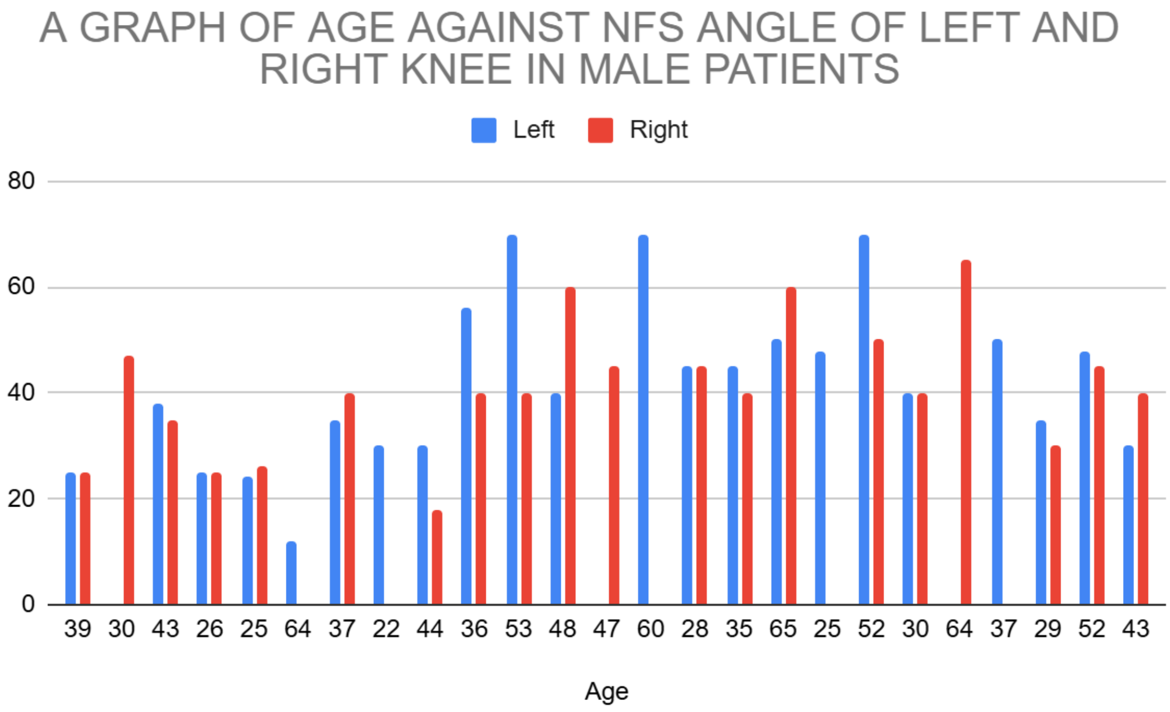

Figure 2: Graph of age against NFS angle of left and right knee in male patients

5.3 Study Of Correlation Of Femoral Neck Shaft Angle And MCL Tension

Female patients

Table 6: Femoral Neck Shaft angle in women

Age	Left	Right
21	116	112
21	118	114
28	124	120
28	128	130
38	116	122

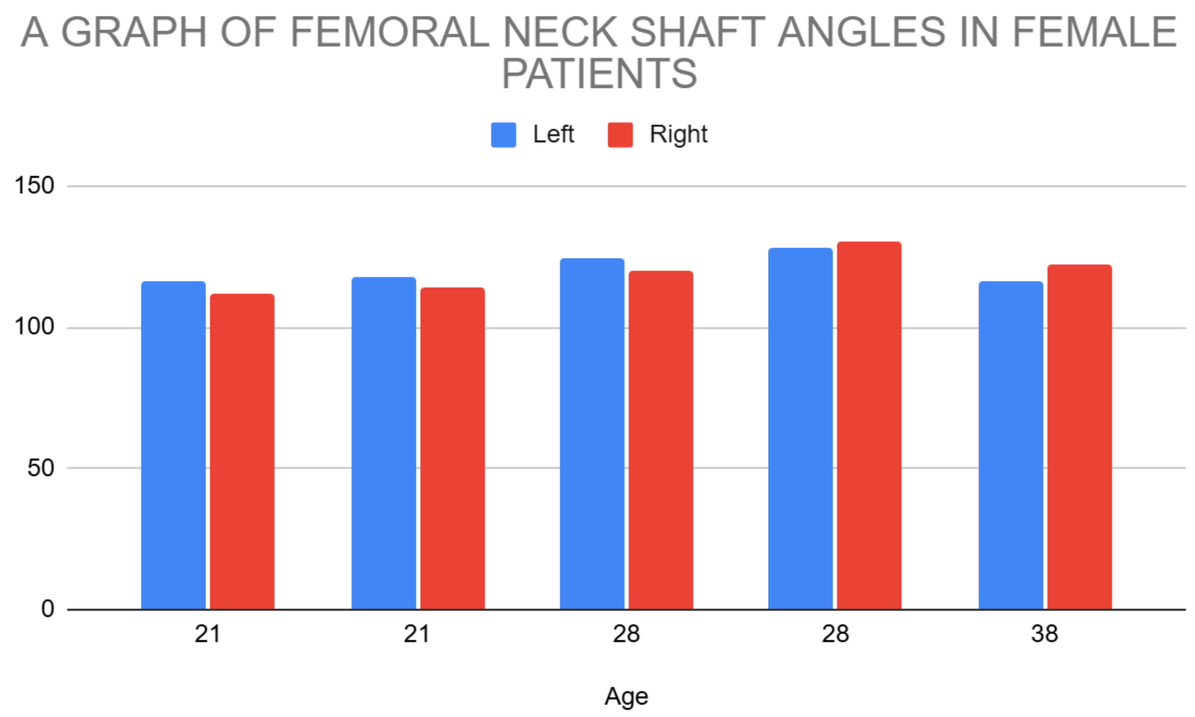

Figure 3: Femoral Neck Shaft Angles in female patients

Male patients

Table 7: Neck Shaft angle values in men

Age	Left	Right
21	130	124
22	118	124
27	126	122
30	118	124
31	125	126

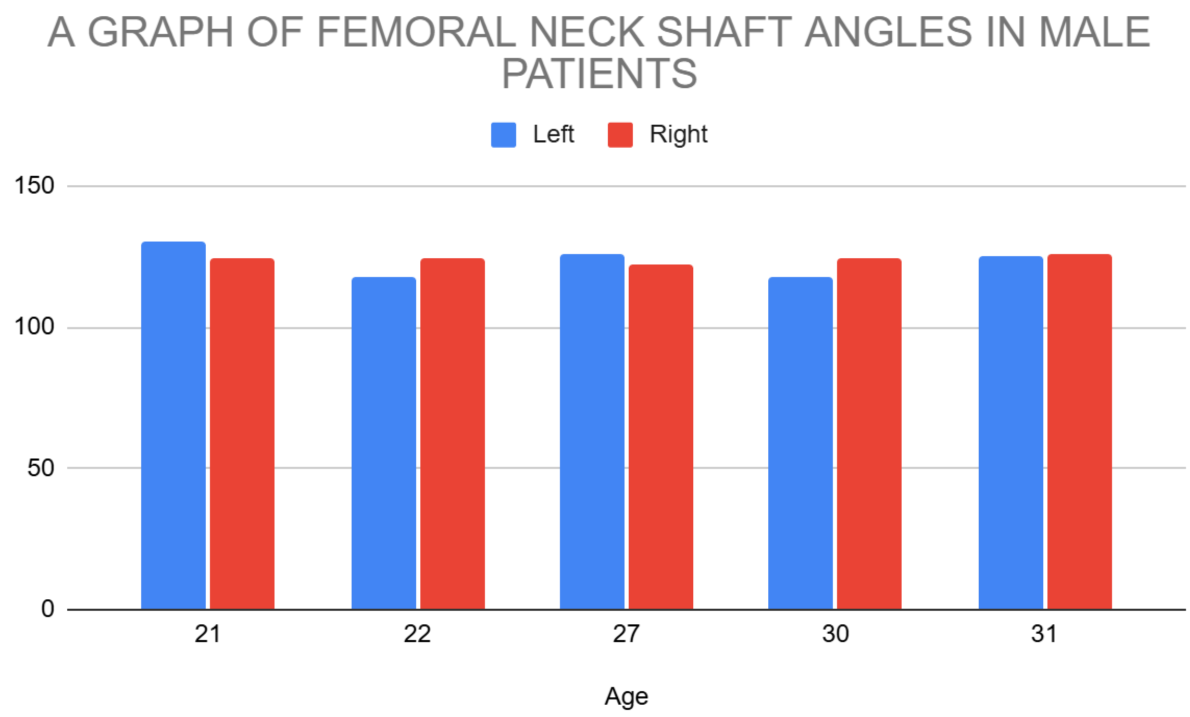

Figure 4: Femoral Neck Shaft angles in male patients

In females the Femoral Neck Shaft angle is smaller compared to males hence female patients are at higher risk of medial deviation of the femur in relation to the tibia hence leading to MCL stress and predisposition to microtears and injury to the MCL causing chronic pain.

6. BIOMECHANICS OF THE STUDY

6.1 Femoral Neck Shaft Angle

The femoral neck-shaft angle is the angle formed between:

- The axis of the femoral neck, which connects the femoral head to the shaft.
- The longitudinal axis of the femoral shaft, which runs vertically down the thigh.

This angle is crucial for:

- Hip joint articulation
- Weight transmission from pelvis to lower limb
- Gait mechanics and limb alignment

The NSA typically ranges from 120° to 145°, with an average of 135°, though this varies based on age, sex, ethnicity, and individual biomechanics.

In adult females the angle ranges from 125 degrees to 135 degrees with decrease mainly due to estrogen deficiency and gynecoid shaped pelvis.

The NSA determines how the femoral head sits within the acetabulum and influences:

- Joint stability
- Muscle leverage and force distribution
- Risk of hip fractures and degenerative changes

A larger NSA (coxa valga) results in a more vertical femoral neck, reducing the bending moment but increasing joint instability. A **smaller NSA** (coxa Vara) increases the bending moment, potentially leading to displacement of the femur medially in relation to the tibia causing stress on the MCL leading to predisposition to microtears and injury causing chronic pain.

6.2 Quadriceps angle

What is the quadriceps angle and why is it significant to this study?

The quadriceps angle is an angle formed between a line representing the resultant line of force of the quadriceps, (connecting a point near the anterior superior iliac spine at the midpoint of the patella and a line from the center of the tibial tubercle. Women at 17 degrees tend to have a wider Q angle than men 12 degrees. This is necessary for our study as we aim at attempting to compare the variation in women as they age and if the medial cruciate ligament plays any role with increased strain on it. Our study attempts to have data from Q angle measured from actual patients and their scans.

6.3 Neurofascial Strain angle

What is the NFS angle and why is significant to this study?

The NFS angle (Neurofascial Strain angle) is a study-specific parameter introduced to quantify the angular deviation or tension distribution across the medial aspect of the knee joint, particularly in relation to the medial cruciate ligament (MCL). It is measured by assessing the alignment between the femoral shaft, tibial plateau, and associated fascial planes during weight-bearing and dynamic motion.

This angle is significant to our study for the following reasons:

- **Biomechanical Insight**: It provides a novel metric to assess how fascial and ligamentous tension shifts with age, hormonal changes, and altered Q-angle dynamics.
- **Correlation with MCL Strain**: A higher NFS angle may indicate increased medial tension, potentially predisposing the MCL to microtears or degeneration.
- **Diagnostic Potential**: When combined with Q-angle and imaging data, the NFS angle may serve as a predictive marker for early ligamentous stress in

7. Recommendations, Innovation and Conclusion

7.1 Is Hormone Replacement a Foreseeable Solution in This Research

As much as the entire research trickles down to the fact that at post-menopausal age the estrogen amount decreases in the women hence causing the medial ligament strain and inevitably causing its tear, it is necessary to understand that hormone replacement therapy especially with estrogen has been strongly linked to the development of breast cancer which is a leading cause of oncology related deaths in the women in our set-up.

With this in mind, this study aims at understanding the etiology from the basic biochemistry, physiology and anatomy of the medial cruciate ligament stress and tear and to provide safer methods of alleviating this issue.

Despite the introduction of alternative therapies such as raloxifene (estrogen hormone receptor sensitizer) being introduced into the market, it is with great concern that this therapy may to some level be carcinogenic.

In this study, we looked into the components of the ligaments. These include: (collagen type 1, fibroblasts, proteoglycans and glycosaminoglycans). If further biochemistry analysis is to be looked into, we noticed that Vitamin c is necessary for collagen formation pathway. Of note is that vitamin c is not just necessary for collagen formation hence it will increase the tensile strength of medial cruciate ligament but it has been proven to be effective in sensitizing estrogen hormone receptors in multiple organs. However, of the bone is not yet identified (possible question in the study)

7.2 What is the benefit of Vitamin c over Raloxifene?

Unlike raloxifene, Vitamin c has an antioxidant effect, therefore its supplementation will not only increase the laxity of the ligaments, but also enhance the bone sensitivity to the reduced amount of estrogen in post-menopausal women while being protective against causation of breast cancer due to its antioxidant effect.

7.3 Knee Brace Innovation

A knee brace is a medical device that stabilizes your knee joint and holds it in place. Healthcare providers use braces to protect and support your knee after an injury.

The knee brace innovation is specifically targeted at reducing the tension at the medial collateral ligament which is more at risk of tearing in women especially those of 45 years of age and above, it is also aimed at enhancing better ventilation than those in the market at the moment.

7.4 Design of The Knee Brace

We have divided the knee brace design into structure, lining, padding strapping and adjustability.

7.5 Structure

This particular perspective is necessary for providing the brace with strength and stability. With this in mind, the material of choice is reinforced plastic (polypropylene). The advantages of this material is:

- Affordability
- Light weight
- Decent rigidity

7.6 Padding and Comfort Layers

Padding and comfort are necessary in every sports-oriented product; however, it is necessary to ensure comfortability and proper ventilation while at it. Studies have shown that sports goods that lack proper ventilation provide appropriate conditions for microorganism growth hence causing skin infections. In this perspective of our knee brace design, we opted for the polyester fabric.

7.7 Strapping and Adjustability

Having drawn scientifically proven data in our research paper, we noted that it is of important to provide a reduction of tension at the medial collateral ligament, especially in women and those born with genu valgus stress. Taking this into consideration, the strapping of our knee brace will enable stability of the medial collateral ligament at its attachment to the tibia and femur while providing a lateral pull to the center of the medial collateral ligament to prevent or even completely eradicate the possibilities of any medial collateral ligament tear.

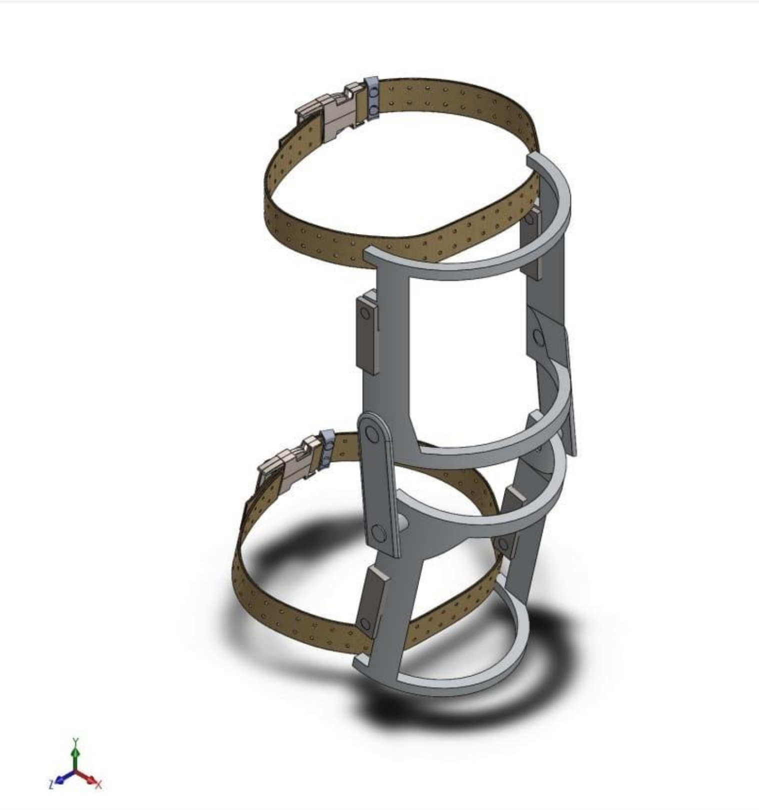

Figure 5: Knee brace design skeleton

Conclusion

In conclusion, 21.4% of post-menopausal women suffer from chronic knee pain in Kenya. It is therefore necessary that assessment of the medial collateral ligament tension should be incorporated into the basic care of these women in attempt to cipher whether the knee pain is a result of osteoporosis or due to increased MCL tension so as to ensure adequate care is granted to these patients. In this research, we have delved into the intricate details of the description of anatomical alignment of the female which predisposes them especially to the medial collateral ligament tension or even tears. This hypothesis has been backed up with statistical analysis of data including measurements of (quadriceps angle, neurofascial angle and femoral neck shaft angle) of both the subjects and control group. In an attempt to alleviate of possibly eradicate this condition we have suggested the nutritional need for Vitamin C ligament which is essential in enhancing ligament laxity and tensile strength as proven by the data collected. This research paper also incorporates the design of a knee brace that is modified to specifically target the medial collateral ligament with the aim of reducing its tension.

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