A Comparison in Levels of Vitamin D Between Patients with Osteochondral Lesions of the Knee and Other Knee Pain Diagnoses

LT Michael F. Tikson, DSc, PA-C, MAJ Garrett Latham, DSc, PA-C, MAJ (Ret) Meghan Joyce, DSc, PA-C, COL (Ret) Rodney X. Strudvant, PhD, Lt. COL. David Oettel, MD

ABSTRACT

Osteochondral lesions are debilitating injuries that cause significant pain and limitation in athletic endeavors and activities of daily living. Osteochondral lesions result from mechanical, anatomical, biological, and hereditary factors, with a recognition that the development of osteochondral lesions is typically multifactorial. Having low levels of Vitamin D is one such biological factor that researchers are looking at more closely. While low Vitamin D levels are implicated in bone and cartilage health, their role in osteochondral lesions is still not well researched. This study compared serum 25-hydroxy-D [25(OH)D] levels in patients with osteochondral lesions of the knee (OLK) and those with knee pain (KP) but no lesions. We rejected the hypothesis that OLK patients have lower 25(OH)D levels than the KP patients. The OLK group (15 patients) had an average 25(OH)D level of 27.0 ± 6.76 ng/mL, while the KP group (91 patients) had 28.8 ± 8.52 ng/mL (p=0.33). Age and sex differences were significant. Further research is needed to explore Vitamin D's role in preventing OLKs.

Osteochondral lesions of the knee are complex injuries causing significant pain and limiting daily activities and athletic performance. When discussing osteochondral lesions, it is important to differentiate adult osteochondral lesions and lesions that develop in juveniles, generally referred to as osteochondritis dissecans. Adult osteochondral lesions are usually thought to develop as the result of an acute trauma or repetitive microtrauma, but he contribution of vascular issues and other biological factors cannot be ruled out. It is common to attribute osteochondritis dissecans to a congenital factor or issue that arose during growth, such as ischemic insults and poor bone mineralization[1-6]. This study ultimately focused on adult osteochondral lesions. Regardless of whether the patient is treated with conservative or surgical treatment, osteochondral lesions, anywhere in the body, can significantly adversely affect patients' lives for months or even years[7]. Despite nearly 300 years of research, the exact etiology of osteochondral lesions remains unclear, with factors ranging from biological to mechanical[6]. Recent studies suggest a link between low Vitamin D levels and osteochondral lesions, highlighting the need for further research on prevention.

Vitamin D is crucial for bone health, and its deficiency is widespread in North America and Europe[8-9]. In recognizing that osteochondral lesions are not simply a cartilage issue but inherently involve the subchondral bone as well, researchers began looking at how the various factors that affect bone health could also play a role in the development of osteochondral lesions[9-10]. No studies have specifically linked low Vitamin D to knee osteochondral lesions, though some research exists for other joints. Identifying such a correlation could inform future prevention strategies[12].

Our primary research question is whether patients diagnosed with an OLK have lower levels of 25(OH)D compared to those with a knee pain diagnosis but no OLK. The dependent variable is the presence of OLK, and the independent variable is the level of 25(OH)D. The control group consists of patients with similar initial ICD-10 knee pain-related diagnoses but without an OLK, referred to as the KP group. We hypothesize that patients with an OLK have statistically significantly lower levels of 25(OH)D compared to patients in the KP group.

METHODS

Methodology

This retrospective, cross-sectional, single-site study compared the serum 25-hydroxy-D [25(OH)D] levels between patients with osteochondral lesions of the knee (OLK) and those with knee pain (KP) but no lesions. The study included data on race, age, sex, body mass index (BMI), alcohol, and tobacco use.

Table 1. Summary of Demographic Variables

	Overall N=106	KP Group n=91	OLK Group n=15	*p*-value[a]
Age	26.8 ± 8.2	25.2 ± 7.3	36.40 ± 6.8	**<0.001**
BMI	25.5 ± 5.4	25.2 ± 5.53	27.7 ± 4.0	0.05
Sex				**<0.001**
Male	44 (42%)	31 (34%)	13 (87%)	
Female	62 (58%)	60 (66%)	2 (13%)	
Race				.98
White	48 (45%)	40 (44%)	8 (53%)	
Black	27 (25%)	24 (26%)	3 (20%)	
Hispanic	13 (12%)	11 (12%)	2 (13%)	
Asian/Haw/PI	16 (15%)	14 (15%)	2 (13%)	
American Indian	2 (1.9%)	2 (2.2%)	0 (0%)	
Alcohol Use (%) Yes	29 (27%)	23 (25%)	6 (40%)	.35
Tobacco Use (Yes)	14 (13%)	11 (12%)	3 (20%)	.42
Active Duty (Yes)	94 (89%)	79 (86%)	15 (100%)	

[a]Wilcoxon rank sum test; Pearson's Chi-squared test; Fisher's exact test

Table 2. Average 25(OH)D by OLK and KP Groups

	Overall, N=106	KP, n=91	OLK, n=15	*p*-value[a]
25(OH)D Levels (ng/mL)	28.5 ± 8.29	28.8 ± 8.52	27.0 ± 6.76	0.33
25(OH)D Levels (ng/mL)	28.5 ± 8.29	28.8 ± 8.52	27.0 ± 6.76	0.33

[a]Wilcoxon rank sum test

Participants

Following the Investigational Review Board authorization, we reviewed records utilizing the San Antonio Military Health System (SAMHS) Management Analysis and Reporting Tool. The inclusion criteria were all patients treated in SAMHS, aged 5-45, with an ICD-10 knee-pain-related diagnosis between January 1, 2015, and January 1, 2024, serum 25(OH)D laboratory results within 30 days of diagnosis, and an MRI of the affected knee within one year of the diagnosis. Exclusions included recent Vitamin D intake, diseases affecting serum analysis, severe knee osteoarthritis (Kellgren-Lawrence grade 3 or 4), active infection, and other knee conditions[13].

Powering

Telleria et al. showed that patients with talar osteochondral lesions had statistically significantly lower 25(OH)D levels than patients who had ankle sprains, 31.2 ± 12.6ng/mL and 37.1 ± 13.5ng/mL respectively (p=0.04). We felt assessing the 25(OH)D levels in those with OLK against patients presenting similar chief complaints was important, as Telleria et al. had done. Using the findings from their study, we calculated a sample size of 60 knees per group with an alpha of 0.05 and power of 0.80 would be adequately powered[12].

Analysis

We reviewed MRI findings and graded for osteochondral lesion severity using Dipaola et al.'s classification system[14]. We analyzed data on OLK presence, severity, 25(OH)D levels, and confounding variables. Statistical tests compared variables between OLK and KP groups, reporting p-values and odds ratios.

RESULTS

After applying the inclusion criteria, we identified 146 potential subjects. Exclusion criteria removed 40 subjects due to vitamin D supplementation, tumors, diseases affecting serum analysis, septic joints, and fractures, leaving 106 knees (15 OLK, 91 KP). (Table 1)

The study sample consisted of 89% active-duty service members with an average BMI of 25.5. Alcohol and tobacco use rates were 27% and 13%, respectively. The sample had 58% females and a higher prevalence of Black individuals compared to the US 2020 Census.

Statistical tests showed significant differences in age (p<0.001) and sex (p<0.001) between OLK and KP groups. OLK patients were older (mean 36.4 vs. 25.2) and predominantly male (87%). We found no significant difference in 25(OH)D levels (p=0.33) (Table 2).

Logistic regression indicated age and sex significantly related to OLK status (Table 3).

Vitamin D

Our primary aim was to investigate if OLK patients have lower levels of 25(OH)D than the control group. The median 25(OH)D levels showed no significant difference, demonstrated by the density plots in Figure 1 (p=0.33). These graphs also show relatively normal distributions within each group, so a parametric test (t-test) was justifiable, but the conclusion was unchanged. There was no significant difference between the two groups (p=0.39). Logistic regression also found no association (p=0.44), with an odds ratio of 0.97 (CI 95%, 0.91-1.04). (Figure 1)

Table 3. Univariate Logistical Regression Models for Demographic Variables

Characteristic	OR[a]	95% CI[a]	*p*-value
25 OH(D) Level	0.97	0.91, 1.04	0.44
Age	1.19	1.10, 1.31	**<0.001**
BMI	1.08	0.98, 1.19	0.13
Sex			**<0.001**
Male			
Female	0.08	0.01, 0.31	
Race			0.89
White			
Black	0.63	0.13, 2.4	
Hispanic	0.91	0.13, 4.31	
Asian/Haw/PI	0.71	0.10, 3.29	
American Indian	0	0	
Alcohol Use (Yes)			0.25
No OLK			
OLK Present	1.97	0.60, 6.08	
Tobacco Use (Yes)			0.35
No OLK			
OLK Present	1.82	0.37, 6.89	

[a]OR= Odds Ratio, CI= Confidence Interval

Age

OLK patients were older, averaging 36.4 years, compared to 25.2 in the control group. The odds of having an OLK increased with age (p<0.001), with an OR of 1.19 per year (CI 95%, 1.10,1.31). (Figure 2)

Sex

The study included 44 knees from males and 62 from females. OLKs were more common in males (87%), with an OR of 0.08 for females (CI 95%, 0.01, 0.31, p<0.001). (Figure 3)

Multivariant Logistical Regression

Multivariate analysis confirmed age and sex as significant predictors. Controlling for age, the OR for females was 0.11 (p=0.009). Controlling for sex, the OR per year increase in age was 1.17 (p=0.004).

DISCUSSION

Our findings showed that despite the lack of statistical significance, the mean 25(OH)D level was lower in the OLK group, indicating a potential Vitamin D insufficiency and both the OLK and KP groups had 25(OH)D levels below the recommended minimum (27.01ng/mL and 28.75ng/mL,

Fig 1. Density Plots of 25(OH)D by OLK

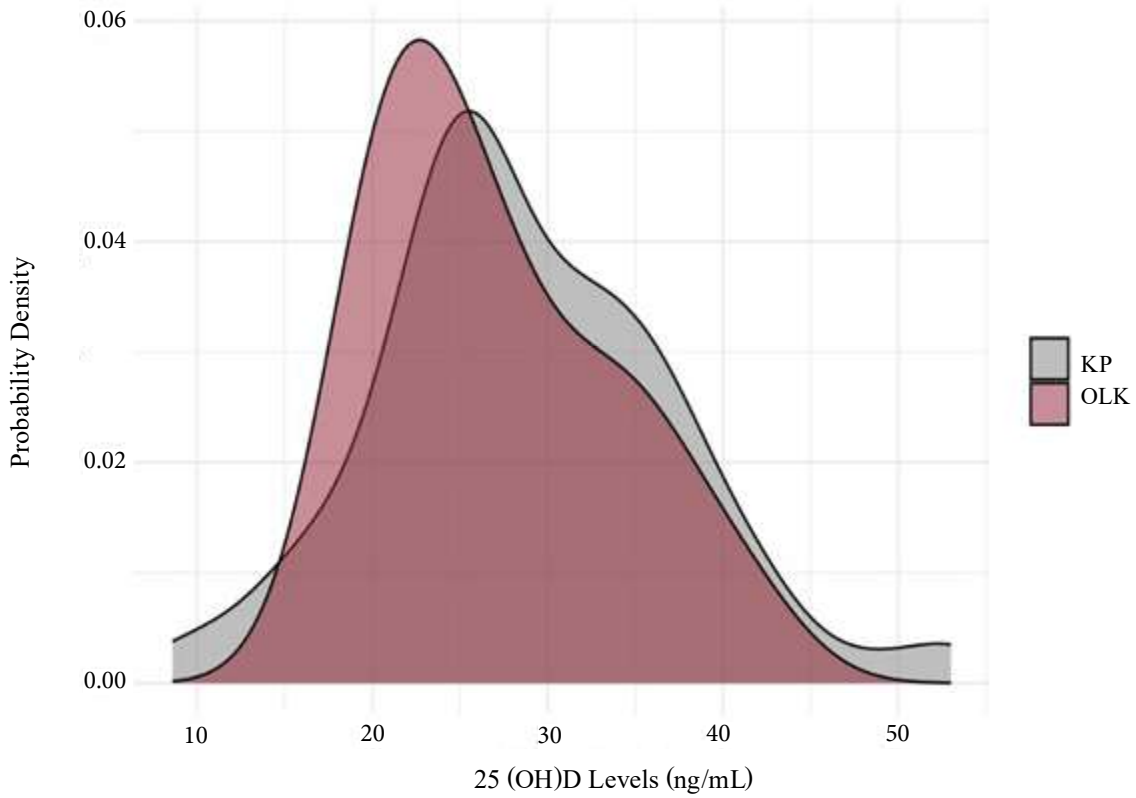

Fig 2. Density Plots of Age by OLK

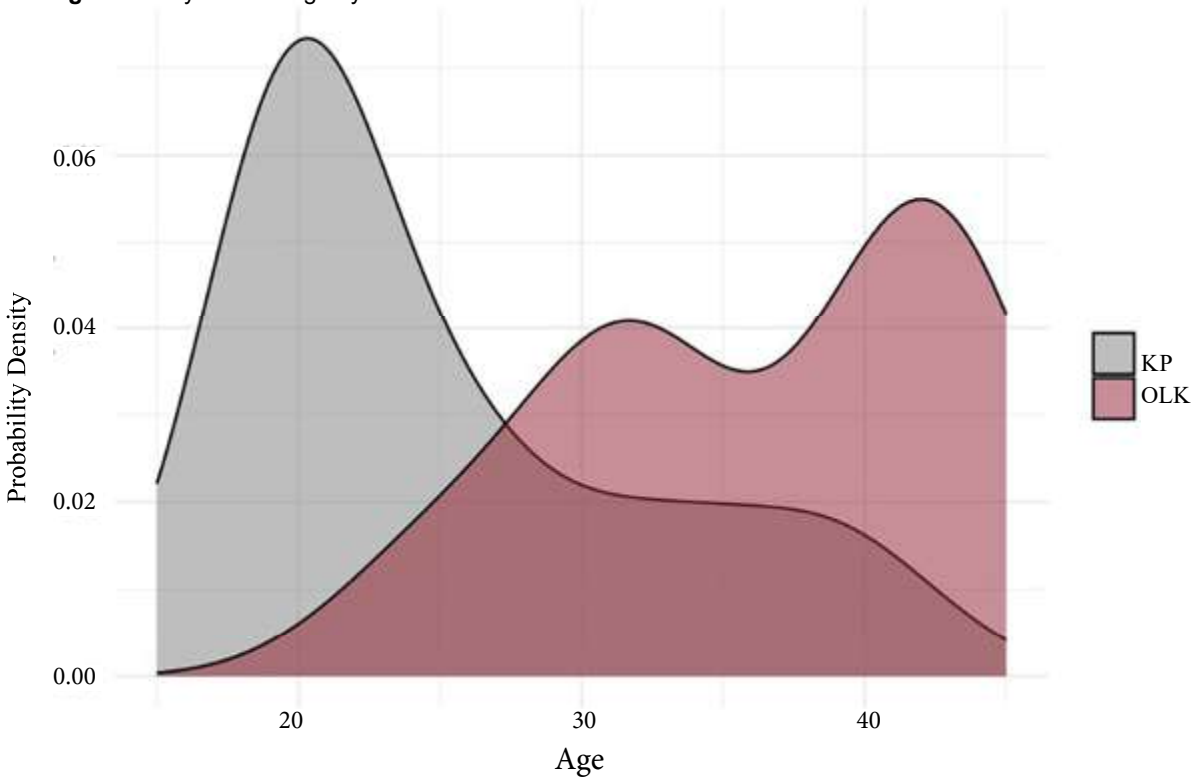

Fig 3. Mosaic Plot of OLK by Sex

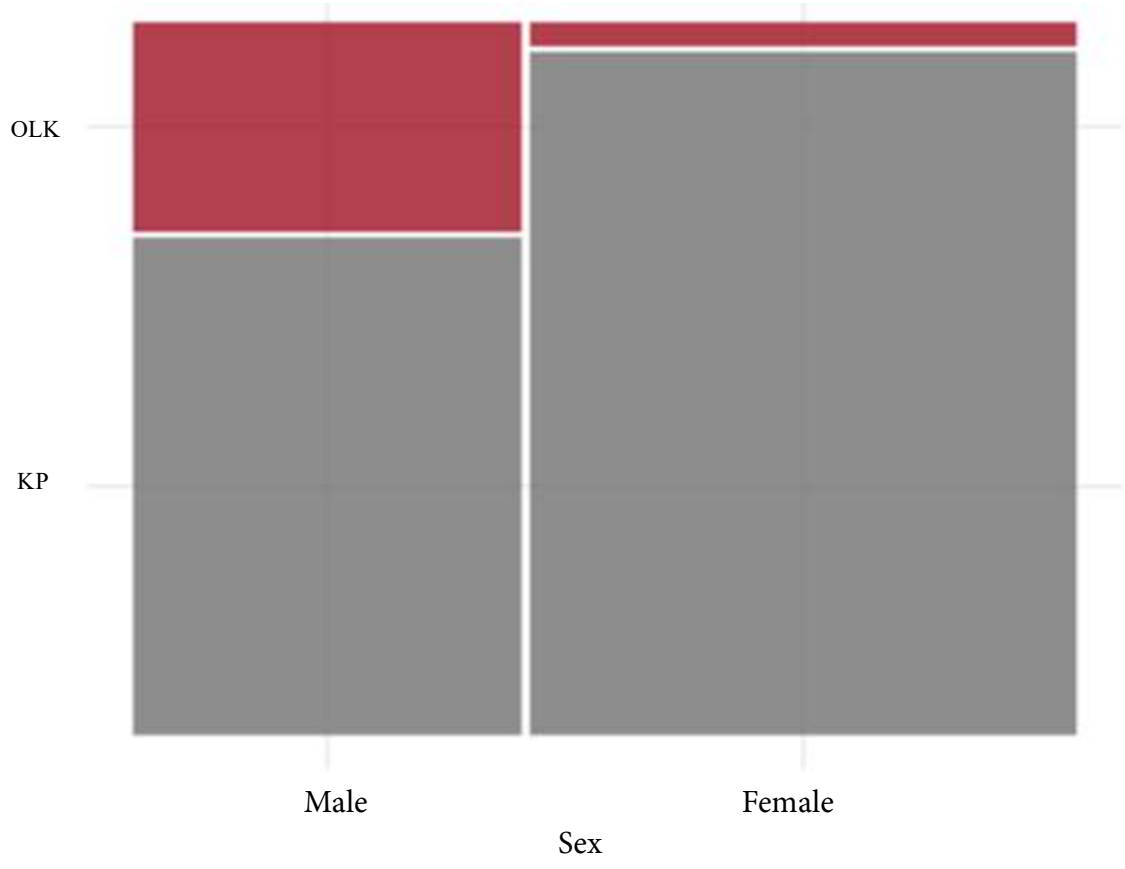

Table 4. Dipaola etal.'s Osteochondral Lesion Severity Grading System

Grade	Description
1	Thinning of cartilage and low signal change
2	Articular cartilage breached with low signal rim underneath
3	Articular cartilage breached with high signal rim underneath
4	Loose body

respectively), with no significant difference between them. This finding suggests that patients with knee pain might benefit from Vitamin D supplementation.

In our study, 67% of OLK patients had low Vitamin D levels, about three times higher than Herrick et al.'s findings[15]. Literature commonly shows low 25(OH)D levels in patients with osteochondral lesions, especially those needing surgery, suggesting a potential role in lesion development[12, 16-19].

OLK patients were older, averaging 36.4 years compared to 25.2 in the control group. This age aligns with some studies but contrasts with others showing higher incidence in younger age groups[12,16-17]. However, it is important to note that our study did not include juveniles, and epidemiological studies generally find peak prevalence of osteochondral lesions before skeletal maturity[1,17,20] Our study found older age to be a significant risk factor for OLK. Males were more likely to have OLKs (87% of OLK cases) despite females comprising 62% of the study population, consistent with epidemiological data showing higher male risk[1,16,20].

We graded all OLKs as low severity (Grade 1) per Dipaola et al.'s grading scale, possibly due to selection bias from requiring 25(OH)D labs, which might exclude more severe cases[14]. None of the OLKs required surgery, aligning with the literature on low-grade lesions[20]. Most study participants were active-duty service members (89%), with all OLKs found in this group likely due to the repetitive stress and trauma associated with military service. (Table 4)

LIMITATIONS

The study had several limitations. The 30-day window for 25(OH)D levels and one-year window for MRI scans may have introduced variability. The study did not meet power analysis goals, affecting its ability to detect significant effects. Of 665 initial patients, only 146 had a knee MRI within a year, and we excluded 40 due to Vitamin D supplementation. This may have impacted the study's reliability. The study's military population limits generalizability to the civilian population.

RECOMMENDATIONS

Future studies should be cross-sectional, correlational, and prospective, and include 25(OH)D testing in OLK evaluations, ideally within two weeks of MRI. A sample size of at least 60 knees per group (OLK and no OLK) is recommended. Intake forms should distinguish between traumatic and insidious onset to provide valuable insights. Using three musculoskeletal radiologists to assess MRI severity would enhance construct validity. Study participants should be age – and sex-matched with a civilian population to also improve external validity. Data collection is recommended to take two to four years.

CONCLUSIONS

We found no significant difference in Vitamin D levels between OLK and KP patients. Vitamin D testing is not yet standard in OLK diagnosis and treatment but should be considered for optimizing patient care in this population. Future prospective studies should include 25(OH)D testing to better understand its role in preventing OLK.

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