Testing Association Between Vitamin D and Osteoarthritis Pain in Total Knee Arthroplasty Patients

Fine, Andrew[1]; Dasa, Vinod MD[2]; Leonardi, Claudia PhD[3]; Marrero, Luis PhD[2]; Simkin, Jennifer PhD[2]

1. Lake Erie College of Osteopathic Medicine, Elmira, NY
2. Department of Orthopedic Surgery, School of Medicine, LSUHSC-New Orleans, LA
3. Behavior and Community Health Sciences Program, School of Public Health, LSUHSC-New Orleans, LA

Introduction

Osteoarthritis is the most common joint disorder affecting 12% of US adults ages 25-74 years old (1). Osteoarthritis is defined as evident cartilage loss without inflammatory or crystal arthropathy (2) with joint pain being the defining symptom (3). Vitamin D plays a role in bone remodeling that may impact osteoarthritis pain. The main role of vitamin D is to maintain adequate serum calcium and phosphate concentrations. This is accomplished by actions in the intestines, kidneys, and bone. Most important to the progression of osteoarthritis is vitamin D's role in bone remodeling. Sufficient vitamin D ensures the calcium stores in bone do not have to be mobilized to keep serum calcium levels constant (4).

Black patients have been reported to have lower levels of vitamin D. The high melanin content in their skin blocks UV radiation needed in vitamin D production. Black patients have also reported consuming less vitamin D in their diet (5). Surprisingly, Black patients' risk for osteoporosis is lower. This may be due to other adaptations, not yet understood (5). Investigation into vitamin D levels and pain in black patients may provide insight to further understand this finding.

In this study, a possible relationship between vitamin D and pain in osteoarthritis is investigated. Furthermore, discrepancies will be investigated between White and Black patients. By comparing vitamin D levels to reported pain (Knee Osteoarthritis Outcome Score) a better understanding of vitamin D's role in disease progression and symptoms can be investigated. This index could be used to predict total knee arthroplasty (TKA) pain outcomes and aid in supplementation recommendations for TKA candidates.

Methods

- 100 frozen serum samples were chosen from a TKA repository of 350 New Orleans, LA patients.
- Patients were separated by race and sex, then sorted in ascending order of pain scores and chosen periodically to represent all reported pain scores.
- Preoperative osteoarthritis pain was collected for each patient through the Knee Osteoarthritis Outcome Score (KOOS) survey.
- Serum levels of 25(OH)D were evaluated by Enzyme-linked immunosorbent assay (ELISA).
- Spearman correlation and ANCOVA were conducted for statistical analysis

Vitamin D vs Preoperative Pain Scores

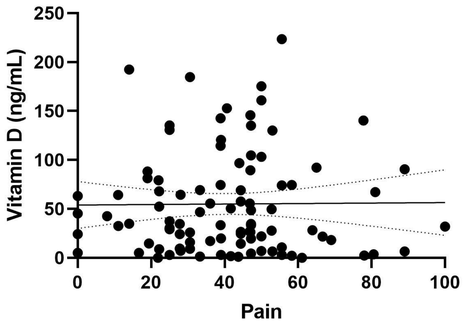

Figure 1 Vitamin D vs Preoperative pain scores (KOOS).

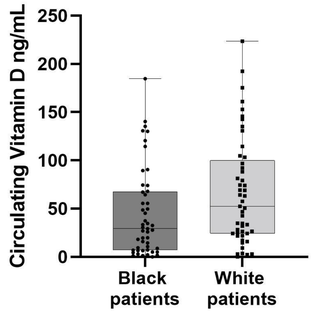

Figure 2 Distribution of vitamin D levels between black and white patients.

Sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Female	49	51.04	49	51.04
Male	47	48.96	96	100.00

Race	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Black	49	51.04	49	51.04
White	47	48.96	96	100.00

Figure 3 Demographic Information on chosen patients.

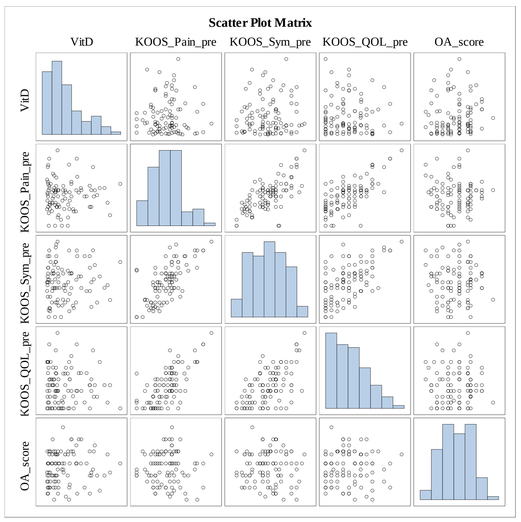

Figure 4 Scatter Plot Matrix
VitD: Vitamin D
KOOS Pain Pre: Preoperative Pain Scores
KOOS Sym Pre: Preoperative Symptoms Scores
KOOS QOL Pre: Preoperative Quality of Life Scores
OA Score: Osteoarthritis Scores

Results

Results showed no significant correlation between serum 25(OH)D levels and preoperative osteoarthritis pain. There was a significant difference in serum 25(OH)D levels between black and white patients, with white patients more likely to have higher 25(OH)D levels than black patients (p=0.045). 31% of patients were vitamin D deficient (<20 ng/mL) and 44% of patients had inadequate levels (<30 ng/mL) of vitamin D.

Conclusions

While there was not a correlation between pain and natural vitamin D levels, there was a significant finding that 31% of patients were vitamin D deficient (<20 ng/mL) and 44% of patients had inadequate levels (<30 ng/mL) of vitamin D prior to surgery. Vitamin D cutoffs taken from clinical practice guidelines (6). Our results suggest that 4 out of 10 New Orleans TKA patients, irrespective of race, sex, age, and BMI have low vitamin D levels. This statistic may only be applicable to adults with limited mobility preparing for TKA. Seeing that such a large percentage of patients have inadequate 25(OH)D levels and the effects it has on bone density, measuring bone density prior to TKA may have significant impacts on surgical procedure and outcome.

Further Studies could investigate parathyroid hormone (PTH) levels and their association with pain in osteoarthritis patients. PTH plays a role in bone resorption and hyperparathyroidism can lead to osteitis fibrosa cystica (OFC).

Sources

1. Cisternas, M.G., Murphy, L., Sacks, J.J., Solomon, D.H., Pasta, D.J. and Helmick, C.G. (2016), Alternative Methods for Defining Osteoarthritis and the Impact on Estimating Prevalence in a US Population-Based Survey. Arthritis Care & Research, 68: 574-580.
2. Glyn-Jones S, Palmer AJ, Agricola R, Price AJ, Vincent TL, Weinans H, Carr AJ. Osteoarthritis. Lancet. 2015 Jul 25;386(9991):376-87. doi: 10.1016/S0140-6736(14)60802-3. Epub 2015 Mar 4. PMID: 25748615
3. Zhu S, Zhu J, Zhen G, Hu Y, An S, Li Y, Zheng Q, Chen Z, Yang Y, Wan M, Skolasky RL, Cao Y, Wu T, Gao B, Yang M, Gao M, Kuliwaba J, Ni S, Wang L, Wu C, Findlay D, Eltzschig HK, Ouyang HW, Crane J, Zhou FQ, Guan Y, Dong X, Cao X. Subchondral bone osteoclasts induce sensory innervation and osteoarthritis pain. J Clin Invest. 2019 Mar 1;129(3):1076-1093. doi: 10.1172/JCI121561. Epub 2019 Feb 4. PMID: 30530994; PMCID: PMC6391093.
4. Bikle D. Vitamin D: Production, Metabolism, and Mechanisms of Action. [Updated 2017 Aug 11]. In: Feingold KR, Anawalt B, Boyce A, et al., editors. Endotext [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000-.
5. Fischer V, Haffner-Luntzer M, Amling M, Ignatius A. Calcium and vitamin D in bone fracture healing and post-traumatic bone turnover. Eur Cell Mater. 2018 Jun 22;35:365-385. doi: 10.22203/eCM.v035a25. PMID: 29931664.
6. Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, Hanley DA, Heaney RP, Murad MH, Weaver CM; Endocrine Society. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. J Clin Endocrinol Metab. 2011 Jul;96(7):1911-30. doi: 10.1210/jc.2011-0385. Epub 2011 Jun 6. Erratum in: J Clin Endocrinol Metab. 2011 Dec;96(12):3908. PMID: 21646368.

This research project was supported through the LSU Health Sciences Center, School of Medicine