

## Evaluation of Role of Vitamin D in Grip Strength in Post-Menopausal Women with Fracture of Distal End Radius Treated with Closed Reduction and Percutaneous K-Wire Fixation

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### Abstract

**Background:** In the skin, under influence of ultraviolet radiation, 7-dehydrocholesterol is photoconverted to previtaminD<sub>3</sub>, which is converted to Vitamin D<sub>3</sub> (cholecalciferol). In the serum, bound to a Vitamin D binding protein (VDBP), Vitamin D<sub>3</sub> is transported to the liver, where it is hydroxylated to 25(OH)D<sub>3</sub>. In the kidneys, 25(OH)D<sub>3</sub> is further metabolized to 1 $\alpha$ ,25-dihydroxyvitaminD<sub>3</sub> [1,25(OH)D<sub>3</sub>], the biologically active form of Vitamin D. Vitamin D (Cholecalciferol) is known to contribute to muscular function.

In the past decade, various cases of both young and elderly adults have been described, in whom prolonged vitamin D deficiency was associated with severe muscle weakness, often leading to marked disability that improved within several weeks of vitamin D supplementation. However, few studies have been conducted in which muscle strength was objectively quantified in relation to vitamin D status in elderly people.

The purpose of this study was to determine whether the supplementation of vitamin D is associated with grip strength recovery in Post-Menopausal Women after a Distal End Radius fracture treated with Closed Reduction and Percutaneous K-wire fixation.

**Material and Methods:** In this comparative study, Two groups were formed, First group as a case in which vitamin D was supplemented and second group as control in which Vitamin D was not supplemented, both the group had 25 number of post-menopausal women who had Vitamin D level between sufficient range (30-100ng/ml) and were treated with same mode of treatment (closed reduction and Percutaneous K-wire fixation) for Distal end radius fracture. Grip strength recovery (in %) was compared in both the group after a period of 6 months.

**Results:** Final grip strength recovery of all patients came out to be 67%, out of which, in supplemented group it came out to be 73% while in non-supplemented group came out to be 60% with p value of statistically significance proving major difference in grip strength recovery in % at 6 months in both the groups

**Conclusion :** We concluded with our series that vitamin D supplementation significantly helps in improving the grip strength recovery in Post-menopausal women after a Distal End Radius fracture treated with Closed Reduction and Percutaneous K-wire fixation.

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### Introduction

Hand Grip has a critical and important role during the performance of our activity of daily living (ADL), and the grip strength is considered an important measure of recovery in the upper extremity injury specially for wrist and for the evaluation of treatment outcome.<sup>(1)</sup> In the studies on Distal End Radius Fractures (DERFs) has been found that the mean grip strength of the injured hand ranges from 75% to 88% of the uninjured contralateral hand at 1 year after injury.<sup>(2-4)</sup> It has also been reported that at 2 to 4 years after injury, the mean grip strength of injured and contralateral hands are not significantly different in

Post-menopausal women treated with cast or external fixation<sup>(4)</sup>.

Vitamin D regulates Calcium and Phosphorus absorption in our body and has a central role in the mineralization, growth, and remodelling of bone.<sup>(5,6)</sup> In addition, there are studies to suggest that vitamin D contributes to muscle function<sup>(7-12)</sup>. Vitamin D receptors (VDR) have been well described in muscle tissues, and vitamin D is known to facilitate muscle calcium transport and phospholipid metabolism.<sup>(7-9)</sup> Although several studies found no such relationship<sup>(13-15)</sup> In addition, vitamin D supplementation has been shown to increase muscle strength in adults with vitamin D deficiency.<sup>(16-20)</sup>

A few studies have shown that Distal end radius fracture patients have lower vitamin D levels<sup>(21,22)</sup> Thus, the purpose of our study was to determine whether vitamin D supplementation is associated with grip strength recovery in Post-menopausal women (PMW) after Distal end radius fractures treated with closed reduction and Percutaneous K-wire (PKW) fixation.

## Material and Methods

Any Post-menopausal women with Distal end radius fracture treated with closed reduction and percutaneous K-wire fixation was taken in our study. Pre-op vitamin D was measured, those with sufficient vitamin D level of 30-100 ng/ml was considered in our study. Pre-op grip strength of contralateral hand was measured with hand dynamometer and that was adjusted according to the hand dominance. To adjust for hand dominance, we used the simple rule that the dominant hand is about 10% stronger than the non-dominant hand<sup>(23,24)</sup>. All the cases underwent closed reduction and Percutaneous K- wire fixation. Other mode of treatment was not included in our study, because that would have created another comparative group, making our original groups non similar to each causing a bias in our observations. Vitamin D was supplemented in dose of 60,000I.U. Once a week for three months post-operatively on every alternate patient, so that half of the patients have vitamin D supplementation were considered under case group and half with no vitamin D supplementation considered as control group. Regular follow up with the interval of 15 days was done. Removal of cast and K-wire was done after 6 Weeks from the day of operation. Active and passive physiotherapy was started after removal. 6 months after the day of operation grip strength was measured again with the same hand dynamometer.

## Inclusion criteria:

1. Post-menopausal women
2. Distal end radius fracture
3. Pre-op vitamin D level 30 -100ng/ml
4. Treated with Closed reduction and Percutaneous K-wire fixation.
5. Accepted informed consent

## Exclusion criteria:

1. Men because they usually have greater grip strength than women<sup>(25)</sup>, vitamin D levels also affected by sex<sup>(26)</sup>.
2. Those with medical factor affecting vitamin D levels, such as gastro-intestinal or renal disease.
3. Patient with additional carpal bone fracture
4. Did not give informed consent

## Results

1. Our grip strength measurement on presentation was done through use of same hand dynamometer in the unit of scale kg with zero % error, and the mean found to be  $40.48 \pm 4.51$  in supplemented group and  $40.96 \pm 3.58$  in non-supplemented group. With most of the patient coming in range of 40.1 - 45.0 in both the groups.
2. At the end of 6 months the grip strength was again calculated using same hand dynamometer and was found to  $29.48 \pm 3.43$  in supplemented group with maximum in between 30-32 and  $24.8 \pm 2.28$  in non supplemented group with maximum in between 24-26

**Table 1: Final Outcome of grip strength recovery at 6 months in both the groups**  
(N=25 each)

|                             | Supplemented |      | Non Supplemented |      | Total |      |
|-----------------------------|--------------|------|------------------|------|-------|------|
|                             | Mean         | SD   | Mean             | SD   | Mean  | SD   |
| Grip Strength recovery in % | 72.82        | 2.63 | 60.55            | 2.36 | 66.69 | 6.67 |

***P value= 0.000 (Statistically Significant, <0.05)***

Final grip strength recovery of all patients came out to be 67%, out of it, in supplemented group it came out to be 73% while in non-supplemented group came out to be 60% with p value of statistically significance proving major difference in grip strength recovery in % at 6 months in both the groups.



## Discussion

In our series we had 50 Post-menopausal females of age more than 50 years and mean age of supplemented group was  $63.56 \pm 9.95$  years and mean age of non-supplemented group found to be  $60.92 \pm 8.12$  years. The total mean age of all 50 females came out to be  $62.24 \pm 9.11$  years. While in the series of **Hui Jong Lee et al (2013)**<sup>[27]</sup> on distal end radius fracture of 70 post-menopausal females, the mean age found was 63 years. The mean age in both the studies came out to be same that shows probability of having distal end radius fracture is maximum around 63 years in Post-menopausal females this is because of osteoporosis with active involvement in homely work till this age which is usually associated with fall because of weakened neurological response of body in this age.

In our study left sided predominance of fracture was seen in both the groups with 54% of total female

having fracture in their left wrist because its being non dominant side hence more prone to disuse and getting fractured.

In our study, the mechanism of injury most common came out to be bending type as per **Farnandez** classification and extra-articular fracture without ulnar styloid was the most common fracture pattern as per **Frykman** classification proving that it was not associated with high speed trauma and the usual cause of this type of mechanism of injury and fracture pattern is Fall On Outstretched hand (FOOSH) which is more common in this age because of decrease ability to balance in this age group that is Post-menopausal women.

In our study we had taken Post-menopausal females who had Vitamin D in sufficient range because ethically, supplementing Vitamin D to a Vitamin D

deficient women was mandatory (which is not possible in control group) and to supplement Vitamin D to a female who already had serum Vitamin D toxicity may lead to toxic side effect, the mean Vitamin D in our study of all female came out to be  $58.65 \pm 17.43 \text{ ng/ml}$ . This was taken in accordance to this table values which is the interpretation of the machine which we used in our study to check serum Vitamin D level of all the females in our study.

| Interpretation | Vitamin D level (in ng/ml) |
|----------------|----------------------------|
| Deficient      | <10                        |
| Insufficient   | 10-30                      |
| Sufficient     | 30-100                     |
| Toxicity       | >100                       |

Supporting our finding **Bichoff-Ferrari et al<sup>(11)</sup>** also found that in ambulatory persons aged 60 years or more, vitamin D concentrations between 40 and 94 nmol/L were associated with better musculoskeletal function in the lower extremities than concentrations of <40 nmol/L.

Several mechanisms have been suggested to explain the role of vitamin D in muscle function. First, human muscle tissues possess vitamin D receptors through which the genomic pathway influences muscle function.<sup>(8)</sup> In addition, vitamin D has also rapid non genomic actions on calcium transport, which may have a more important role in the present study, because most patients had received vitamin D supplementation for only 3 months.<sup>(7)</sup> Second, vitamin D deficiency has been associated with atrophy of type 2 muscle fiber, which is a fast-twitch fiber and the first to be recruited to prevent a fall. **Sato et al<sup>(18)</sup>** showed that vitamin D supplementation can increase the number of type 2 muscle fibers. Thus, vitamin D supplementation may change the composition of muscle fibers and contribute to the activities of fast-twitch muscle, which include gripping muscles of hand. In addition, we speculate that in our study, vitamin D supplementation was associated with better grip strength recovery, whereas the baseline vitamin D level was not, because injured muscles may need more calcium transport to make them work. Thus, patients may need supplementation of vitamin D more than their baseline vitamin D levels.

Complications seen in our study was total of 10% out of which 4% were Pin site infection and Malunion each and in 2% Sudecks osteodystrophy while 90% of female recovered without any complication. The complication of Pin site infection was diagnosed on high level of suspicion, when patient had pain, swelling of fingers and tightness of cast. Patient complains of some wetness in the cast. In these cases, the cast was slit (window) and treated with regular dressing and oral antibiotics. Malunion patients had non dominant side

and palmar angulation less than  $13^\circ$  without any restriction in range of motion so only treated with ample amount of physiotherapy and the cases of sudecks osteodystrophy were treated by suitable medical treatment along with rest to the wrist followed by physiotherapy.

In this study, baseline vitamin D level was not associated with grip strength recovery at 6 months. Because we did not do interval follow-up of vitamin D levels, we could not explore the cross-sectional relationship between the vitamin D level and grip strength. Thus, assuming that the grip strength of normal hands did not change over time, it appears that grip strength per se, correlates with serum vitamin D levels. Reports regarding the relation between vitamin D level and muscle strength are contradictory. **Bichoff-Ferrari et al<sup>(11)</sup>** found that in ambulatory persons aged 60 years or more, vitamin D concentrations between 40 and 94 mol/L were associated with better musculoskeletal function in the lower extremities than concentrations of <40 mol/L. **Ward et al<sup>(28)</sup>** found a positive relationship between serum vitamin D level and jump height, jump velocity, and muscle strength in adolescent girls. However, **Marantes et al<sup>(15)</sup>** found no consistent association between low vitamin D level and low muscle mass or strength, particularly in older men and women.

A recent metaanalysis of **Stockton KA et al<sup>(29)</sup>** found that vitamin D supplementation did not have a significant effect on muscle strength in adults with a baseline serum vitamin D level of <25 nmol/L. On the other hand, another meta-analysis of **Muir SW et al<sup>(20)</sup>** found that daily supplementation of vitamin D consistently demonstrated beneficial effects on strength and balance.

Other studies in support of our study was of **Janssen HC et al<sup>(30)</sup>** whose evidence indicate that Vitamin D supplementation preserves muscle strength and functional ability in home bound elderly people. **Foo LH et al<sup>(31)</sup>** stated that poor Vitamin D status compromises the forearm muscle strength. **Bunout D et al<sup>(32)</sup>** stated that Vitamin D supplementation improve muscle strength in healthy elderly subjects. **Hui JL et al<sup>(27)</sup>** concluded that in women with Distal end radius fracture, base line Vitamin D is not associated with grip strength recovery while Vitamin D supplementation help in grip strength recovery.

## Conclusion

We found vitamin D supplementation was associated with better grip strength. However, in the present study, we used vitamin D supplementation to treat bone health and proper functioning of muscles and it was not based on preoperative vitamin D levels, although most of the treated patients were vitamin D sufficient. Therefore, it is not certain whether the effect of vitamin D supplementation can be expected in vitamin D deplete patients. We came to the conclusion

that vitamin D supplementation significantly help in improving the grip strength recovery in Post-menopausal women after a distal end radius fracture treated with Closed Reduction and Percutaneous K-wire fixation .

**Conflict of Interest: None**

**Source of Support: Nil**

## References

- Bohannon RW. Dynamometer measurements of hand grip strength predict multiple outcomes. *Percept Mot Skills*. 2001;93(2):323–328.
- Chung KC, Watt AJ, Kotsis SV, Margaliot Z, Haase SC, Kim HM. Treatment of unstable distal radial fractures with the volar locking plating system. *J Bone Joint Surg Am*. 2006;88(12):2687–2694.
- Wei DH, Raizman NM, Bottino CJ, Jobin CM, Strauch RJ, Rosenwasser MP. Unstable distal radial fractures treated with external fixation, a radial column plate, or a volar plate: a prospective randomized trial. *J Bone Joint Surg Am*. 2009;91(7):1568–1577.
- Brogren E, Hofer M, Petranek M, Dahlin LB, Atroshi I. Fractures of the distal radius in women aged 50 to 75 years: natural course of patient reported outcome, wrist motion and grip strength between 1 year and 2-4 years after fracture. *J Hand Surg Eur Vol*. 2011;36(7):568–576.
- Holick MF. Vitamin D: A millenium perspective. *J Cell Biochem*. 2003;88(2):296–307.
- Holick MF. Vitamin D: importance in the prevention of cancers, type1 diabetes, heart disease, and osteoporosis. *Am J Clin Nutr*. 2004;79(3):362–371.
- Capiati D, Benassati S, Boland RL. 1,25(OH)<sub>2</sub>-vitamin D<sub>3</sub> induces translocation of the vitamin D receptor (VDR) to the plasma membrane in skeletal muscle cells. *J Cell Biochem*. 2002;86(1):128–135.
- Endo I, Inoue D, Mitsui T. Deletion of vitamin D receptor gene in mice results in abnormal skeletal muscle development with deregulated expression of myoregulatory transcription factors. *Endocrinology*. 2003;144(12):5138–5144.
- Santillan G, Katz S, Vazquez G, Boland RL. TRPC3 like protein and vitamin D receptor mediate 1alpha,25(OH)<sub>2</sub>D<sub>3</sub>-induced SOC influx in muscle cells. *Int J Biochem Cell Biol*. 2004;36(10):1910–1918.
- Visser M, Deeg DJ, Lips P. Low vitamin D and high parathyroid hormone levels as determinants of loss of muscle strength and muscle mass (sarcopenia): the Longitudinal Aging Study Amsterdam. *JCI in Endocrinol Metab*. 2003;88(12):5766–5772.
- Bischoff-Ferrari HA, Dietrich T, Orav EJ. Higher 25-hydroxy vitamin D concentrations are associated with better lower extremity function in both active and inactive persons aged more than 60 y. *Am J Clin Nutr*. 2004;80(3):752–758.
- Wicherts IS, van Schoor NM, Boeke AJ. Vitamin D status predicts physical performance and its decline in older persons. *J Clin Endocrinol Metab*. 2007;92(6):2058–2065.
- Boonen S, Lysens R, Verbeke G. Relationship between age associated endocrine deficiencies and muscle function in elderly women: a cross-sectional study. *Age Ageing*. 1998;27(4):449–454.
- Annweiler C, Beauchet O, Berrut G. Is there an association between serum 25-hydroxyvitamin D concentration and muscle strength among older women? Results from baseline assessment of the EPIDOS study. *J Nutr Health Aging*. 2009;13(2):90–95.
- Marantes I, Achenbach SJ, Atkinson EJ, Khosla S, Melton LJ III, Amin S. Is vitamin D a determinant of muscle mass and strength? *J Bone Miner Res*. 2011;26(12):2860–2871.
- Glerup H, Mikkelsen K, Poulsen L. Hypovitaminosis D myopathy without biochemical signs of osteomalacic bone involvement. *Calcif Tissue Int*. 2000;66(6):419–424.
- Bischoff HA, Stahelin HB, Dick W. Effects of vitamin D and calcium supplementation on falls: a randomized controlled trial. *J Bone Miner Res*. 2003;18(2):343–35.
- Sato Y, Iwamoto J, Kanoko T, Satoh K. Low-dose vitamin D prevents muscular atrophy and reduces falls and hip fractures in women after stroke: a randomized controlled trial. *Cerebrovasc Dis*. 2005;20(3):187–192.
- Pfeifer M, Begerow B, Minne HW, Suppan K, Fahrleitner-Pammer A, Dobnig H. Effects of a long-term vitamin D and calcium supplementation on falls and parameters of muscle function in community dwelling older individuals. *Osteoporos Int*. 2009;20(2):315–322.
- Muir SW, Montero-Odasso M. Effect of vitamin D supplementation on muscle strength, gait and balance in older adults: a systematic review and meta-analysis. *J Am Geriatr Soc*. 2011;59(12):2291–2300.
- Oyen J, Apalset EM, Gjesdal CG, Brudvik C, Lie SA, Hove LM. Vitamin D inadequacy is associated with low-energy distal radius fractures: a case-control study. *Bone*. 2011;48(5):1140–1145.
- Jang WY, Chung MS, Baek GH, Song CH, Cho HE, Gong HS. Vitamin D levels in post-menopausal Korean women with a distal radius fracture. *Injury*. 2012;43(2):237–241.
- Petersen P, Petrick M, Connor H, Conklin D. Grip strength and hand dominance: challenging the 10% rule. *Am J Occup Ther*. 1989;43(7):444–447.
- Crosby CA, Wehbe MA, Mawr B. Hand strength: normative values. *J Hand Surg Am*. 1994;19(4):665–70.
- Demura S, Aoki H, Sugiura H. Gender differences in hand grip power in the elderly. *Arch Gerontol Geriatr*. 2011;53(1):76–78.
- Hagenau T, Vest R, Gissel TN. Global vitamin D levels in relation to age, gender, skin pigmentation and latitude: an ecologic meta-regression analysis. *Osteoporos Int*. 2009;20(1):133–140.
- Lee HJ, Gong HS, Song CS, Lee JE, Lee YH, Baek GH. Evaluation of Vitamin D Level and Grip Strength Recovery in Women With a Distal Radius Fracture. *J Hand Surg* 2013;38(A):519–525.
- Ward KA, Das G, Roberts SA, Berry JL, Adams JE, Rawer R, Mughal MZ., A randomized, controlled trial of vitamin D supplementation upon musculoskeletal health in post menarchal females. *J Clin Endocrinol Metab*. 2010;95(10):4643–51.
- Stockton KA, Mengersen K, Paratz JD, Kandiah J and Bennell KL: Effect of vitamin D supplementation on muscle strength: a systematic review and meta-analysis, *Osteoporosis International*. 2007;22(3):859–871.
- Janssen HC, Samson MM, Verhaar HJ. Vitamin D deficiency, muscle function, and falls in elderly people. *Am J Clin Nutr*. 2002;75(4):611–5.
- Foo LH, Zhang Q, Zhu K, Ma G, Hu X, Greenfield H, Fraser DR. Low vitamin D status has an adverse influence on bone mass, bone turnover, and muscle strength in Chinese adolescent girls. *J Nutr*. 2009;139(5):1002–7.
- Schreuders TA, Selles RW, Roebroeck ME, Stam HJ. Strength measurements of the intrinsic hand muscles: a review of the development and evaluation of the Rotterdam intrinsic hand myometer. *J Hand Ther*. 2006;19(4):393–401.