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# A Study of Metacarpocortical Index in Chronic Renal Failure

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***Abstract***
***Introduction***
*Chronic renal failure is a pathophysiological process with multiple etiologies resulting in the inexorable attrition of nephron number and function and frequently leading to end stage renal disease.Bone disease is observed in 75-100% of patients with chronic renal failure as the glomerular filtration rate falls below 60 ml/minute.When renal bone disease is assessed using a combination of biochemical markers, histology and bone densitometry, early intervention and the careful use of an increasing number of effective therapies can reduce the morbidity associated with this common problem. One of the earliest radiological changes in chronic renal failure is metacarpocortical index (MCI). It is sum of medial +lateral cortical thickness of second metacarpal bone at mid point divided by total thickness of second metacarpal bone.*
***Aims and Objectives:-***
*1) Early detection of renal osteodystrophy.*
*2) Calculate metacarpocortical index (MCI) and predict quantitative bone changes in Chronic renal failure (CRF) patients.*
*3) Comparison between metacarpocortical index in CRF with biochemical parameters like blood urea, serum creatinine, serum calcium, serum phosphorus, serum alkaline phosphatase, serum uric acid, serum vitamin D3 and survey of axial skeletal region.*
***Materials & Methods:-***
*This study was conducted among 30 patients of chronic renal failure admitted in Department of General Medicine and Nephrology in Government Rajaji Hospital, Madurai and 30 normal persons were taken as control. It is a hospital based cross sectional observational study.*
***Methodology:-***
*This study was done by taking simple X-ray of right hand anteroposterior view to detect metacarpocortical index by measuring medial plus lateral cortical thickness inthe mid shaft of the second metacarpal bone divided by the total thickness of the mid shaft of second metacarpal bone. Metacarpocortical index (MCI) was correlated with simplebiochemical parameters like serum levels of creatinine, urea, calcium, phosphorus, alkaline phosphatase, uric acid, vitamin D3 levels and survey of axial skeletal region.*
***Results:-***
*Total 30 patients diagnosed with chronic renal failure and control of 30 persons were studied. Mean Metacorpocortical index in study group chronic renal failure patients was 0.42 whereas in controls group was 0.69. Metacorpocortical index was decreased by rise of serum creatinine, urea, phosphorus, serum alkaline phosphatase, vitamin d3 and serum uric acid. Metacorpocortical index was increased by increase of serum calcium.*
***Conclusion***
*The study revealed that renal osteodystophy in CRF patients can be measured by simple reliable and accessible method of calculating metacarpocortical index.*
***Keyword:*** *metacarpocortical index, chronic renal failure, renal osteodystrophy*

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## I. Introduction

Chronic renal failure is a pathophysiological process with many etiologies resulting in the inexorable attrition of nephron number and function and frequently leading to end stage renal disease. Uremia is a clinical and laboratory syndrome reflecting dysfunction of all organ systems as a result of untreated or under treated acute or chronic renal failure. Renal osteodystrophy is observed in 75-100% of patients with chronic renal failure as the glomerular filtration rate (GFR) falls below 60 ml/minute. Renal osteodystrophy is an almost

universal consequence of chronic renal insufficiency and is associated with rickets in child hood and osteomalacia in adults, hyperparathyroidism, osteosclerosis and osteoporosis. In normal bone, the remodeling process of removal and replacement is tightly coupled.

Bone biopsy and histomorphometry remains the gold standard for diagnosing renal osteodystropsy. Calcitriol and calcium salts can be used to suppress PTH and improve osteomalacia but there is growing concern that these agents predispose to the development of vascular calcification, cardiovascular morbidity, low-turnover bone disease and fracture. Newer therapeutic options include less calcemic vitamin D analogues, calcimimetics and bisphosphonates for hyperparathyroidism, and sevelamer for phosphate control. Calcitriol and hormone-replacement therapy (HRT) have been shown to maintain bone mineral density (BMD) in certain patients with end-stage renal disease (ESRD). After renal transplantation, renal osteodystrophy generally improves but BMD often worsens. Bisphosphonate therapy may be appropriate for some patients at risk of fracture. When renal bone disease is assessed using a combination of biochemical markers, histology and bone densitometry, early intervention and the careful use of an increasing number of effective therapies can reduce the morbidity associated with this common problem. One of the earliest radiological changes in chronic renalfailure is metacarpocortical index (MCI).

It is sum of medial +lateral cortical thickness of second metacarpal bone at mid point divided by total thickness of second metacarpal bone. This study is conducted to measure bone density by calculating metacarpocortical thickness of second metacarpal bone by X-ray which is simple and reliable method to predict bone changes (MCI index) in comparison with biochemical parameters like serum creatinine, urea, calcium, phosphorus, alkaline phosphatase, uric acid, vitamin D3 and axial skeletal survey which may help in optimising dosage of calcium and vitamin D 3 supplements.

## II. Aim Of Study

1. Early detection of renal osteodystrophy.
2. Calculate metacarpocortical index (MCI) and predict quantitative bone changes in Chronic renal failure (CRF) patients.
3. Comparison between metacarpocortical index in CRF with biochemical parameters like blood urea, serum creatinine, serum calcium, serum phosphorus, serum alkaline phosphatase, serum uric acid, serum vitamin D3 and survey of axial skeletal region.

**STUDY POPULATION:**

This study was conducted on 30 patients of chronic renal failure admitted in Government Rajaji Hospital, Madurai in the department of General medicine and Nephrology. A control group of 30 persons were studied.

**INCLUSION CRITERIA:**

**STUDY GROUP:**

- CRF of any cause
- Both male and female
- Age between 18 to 50 yrs in male
- Age between 18 to 45 yrs in female

**CONTROL GROUP:**

- No evidence of CRF
- Apparently healthy
- Age between 18 to 50 yrs in male
- Age between 18 to 45 yrs in female

**EXCLUSION CRITERIA:**

a) Acute renal failure
b) Bones changes other than CRF
c) Rickets
d) Drug intake (steroids)

## III. Methodology

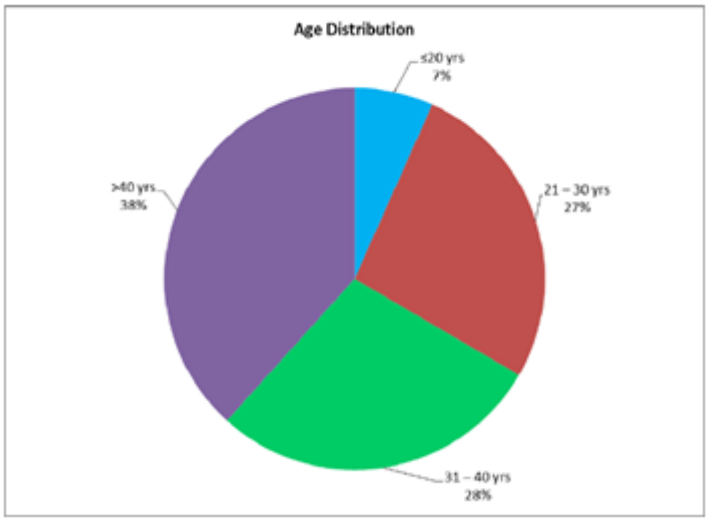
60 patients will be included in the study after obtaining informed consent. Patients included in study were divided into two groups. Study group were people with chronic renal failure age between 18 to 50 years male and 18 to 45 years female. Control group were people were apparently healthy individuals without chronic renal failure age between 18 to 50 years male and 18 to 45 years female. History and clinical examination was taken for each patients. Then X ray right hand AP view taken and axial skeletal survey done. Relevant

laboratory investigations were done. Metacarpocortical index was calculated from X ray right hand and it was statistically analysed with other laboratory parameters and results were obtained. The statistical results of the study of the 60 patients were summarized

**DESIGN OF STUDY:**
Hospital based cross sectional observational study
**PERIOD OF STUDY:**
February 2017 to August 2017
**ANTICIPATED OUTCOME:**
X-ray of right hand for calculating MCI from second metacarpal bone can predict quantitative bone changes which is useful in preventing complications of osteodystrophy (ex : fractures).
**ETHICAL CLEARANCE**
Obtained (Certificate enclosed)
**ANALYSIS**
Statistical Analysis
**CONFLICT OF INTEREST: NIL**
**FINANCIAL SUPPORT: NIL**

## IV. Results

**AGE DISTRIBUTION:-**
38% of patients were more than 40 years, 28% were between 30- 40 years, 27% were between 21 – 30 years and 7% were less than 20 years.

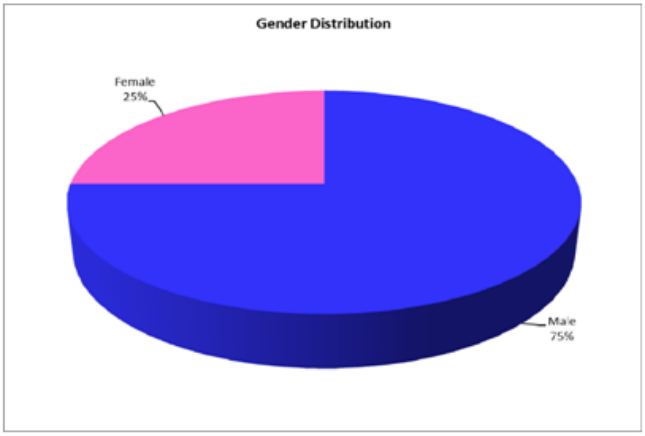



| Age (in yrs) | |
|---|---|
| N | 60 |
| Mean | 36.2 |
| SD | 10.1 |
| Minimum | 18 |
| Maximum | 50 |

| Age group (in yrs) | No. (%) |
|---|---|
| ≤20 | 4 (6.7) |
| 21 – 30 | 16 (26.7) |
| 31 – 40 | 17 (28.3) |
| >40 | 23 (38.3) |
| Total | 60 (100.0) |

Majority of the population for study were contributed by people of age more than 40 years and least by people of 18 to 20 years.

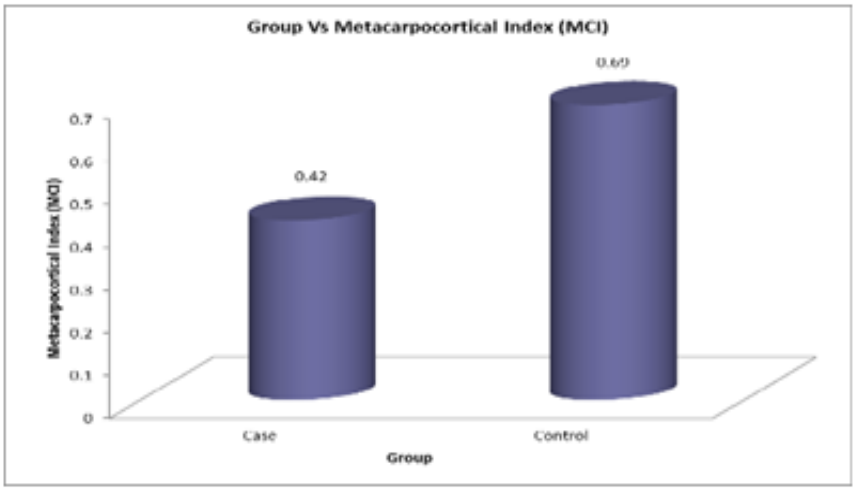
**SEX DISTRIBUTION:-**
Among the 100 people studied 75 % were male and 25% were female.




| Gender | No. (%) |
|---|---|
| Male | 45 (75.0) |
| Female | 15 (25.0) |
| Total | 60 (100.0) |

Males formed the major population for study.

**AVERAGE MCI BETWEEN CASE GROUP AND CONTROL GROUP**

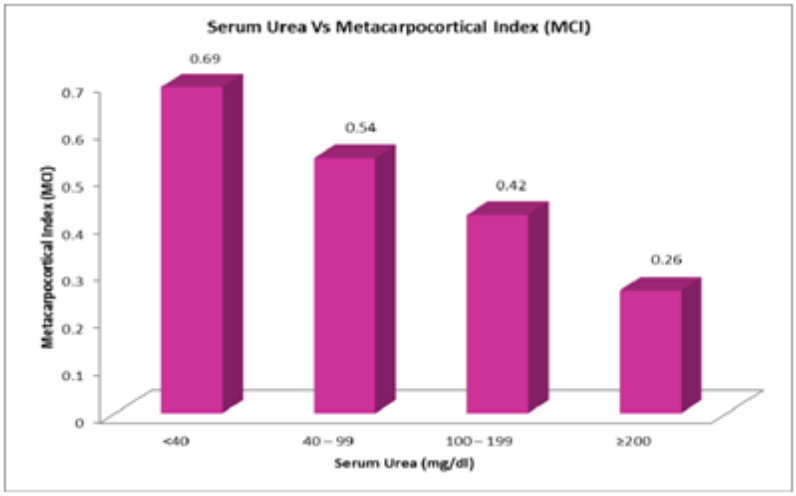



Metacarpocortical index in study group is 0.42 Metacarpocortical index in control group is 0.69

| Group | Metacarpocortical Index (MCI) | | |
|---|---|---|---|
| | N | Mean ± SD | Minimum, Maximum |
| Case | 30 | 0.42 ± 0.10 | 0.22, 0.66 |
| Control | 30 | 0.69 ± 0.11 | 0.47, 0.88 |
| l | 60 | 0.56 ± 0.17 | 0.22, 0.88 |
| **p-value** | **<0.001 (Significant)** | | |

This study compares MCI between case and control group it was less in case group indicating bone loss in chronic renal failure. Results were statistically significant.

**VARIOUS SERUM UREA LEVELS AND METACARPOCORTICAL INDEX OF BOTH CASES AND CONTROLS:-**

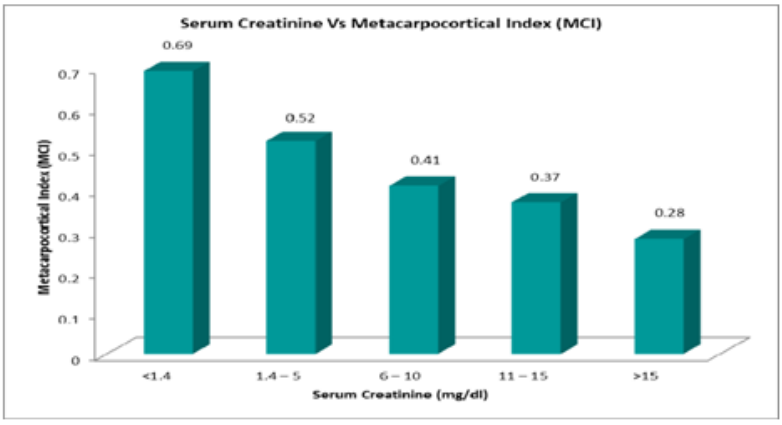



This graph shows that with increase in serum urea, there is decrease in Metacarpocortical index.

| Serum Urea (mg/dl) | Metacarpocortical Index (MCI) | | |
|---|---|---|---|
| | N | Mean ± SD | Minimum, Maximum |
| <40 | 29 | 0.69 ± 0.10 | 0.47, 0.87 |
| 40 – 99 | 10 | 0.54 ± 0.12 | 0.47, 0.88 |
| 100 – 199 | 17 | 0.42 ± 0.08 | 0.31, 0.66 |
| ≥200 | 4 | 0.26 ± 0.03 | 0.22, 0.31 |
| Total | 60 | 0.56 ± 0.17 | 0.22, 0.88 |
| **p-value** | **<0.001 (Significant)** | | |

Above table shows that with increase in serum urea there is decline in metacarpocortical index and it is statistically significant.

**VARIOUS SERUM CREATININE LEVELS AND THE CORRESPONDING METACARPOCORTICAL INDEX**

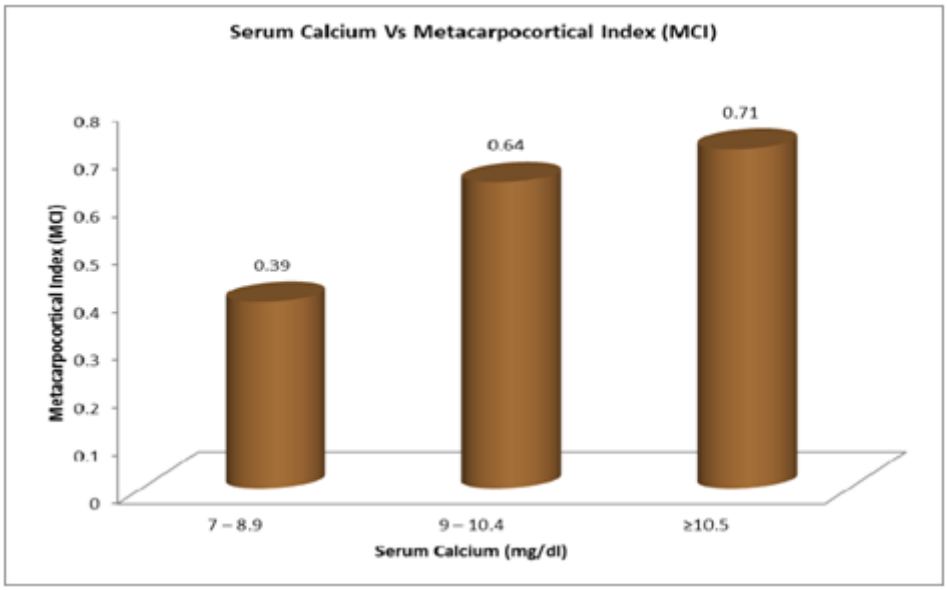



This graph shows with increase in serum creatinine there is fall in metacarpocortical index.

| Serum Creatinine (mg/dl) | Metacarpocortical Index (MCI) | | |
|---|---|---|---|
| | N | Mean ± SD | Minimum, Maximum |
| <1.4 | 30 | 0.69 ± 0.11 | 0.47, 0.88 |
| 1.4 – 5 | 12 | 0.52 ± 0.06 | 0.44, 0.66 |
| 6 – 10 | 9 | 0.41 ± 0.02 | 0.40, 0.45 |
| 11 – 15 | 3 | 0.37 ± 0.06 | 0.31, 0.44 |
| >15 | 6 | 0.28 ± 0.03 | 0.22, 0.33 |
| Total | 60 | 0.56 ± 0.17 | 0.22, 0.88 |
| **p-value** | **<0.001 (Significant)** | | |

This table shows with increase in srum creatinine there is fall in metacarpocortical index and it is statistically significant.

**VARIOUS SERUM CALCIUM LEVELS AND CORRESPONDING METACARPOCORTICAL INDEX:-**

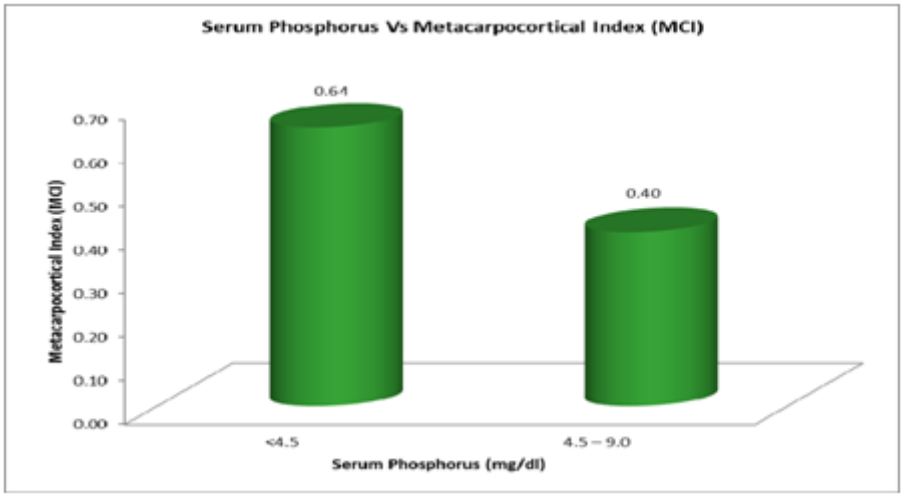



This graph shows analysis between serum calcium and metacarpocortical index It shows that with increase in serum calcium there is increase in metacarpocortical index.

| Serum Calcium (mg/dl) | Metacarpocortical Index (MCI) | | |
|---|---|---|---|
| | N | Mean ± SD | Minimum, Maximum |
| 7 – 8.9 | 22 | 0.39 ± 0.10 | 0.22, 0.72 |
| 9 – 10.4 | 29 | 0.64 ± 0.13 | 0.47, 0.88 |
| ≥10.5 | 9 | 0.71 ± 0.06 | 0.60, 0.80 |
| Total | 60 | 0.56 ± 0.17 | 0.22, 0.88 |
| **p-value** | **<0.001 (Significant)** | | |

This table shows the statistical analysis between serum calcium and metacarpocortical index. It shows that with decrease in metacarpocortical index there is decrease in serum calcium. It is statistically significant.

**VARIOUS SERUM PHOSPHORUS LEVELS AND CORESPONDING METACARPOCORTICAL INDEX:-**

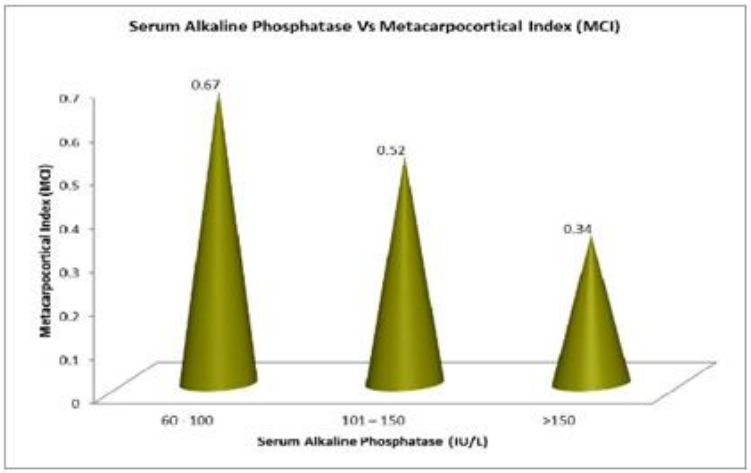


This graph shows that with deccrease in metacarpocortical index there is increase in serum phosphorus.

| Serum Phosphorus (mg/dl) | Metacarpocortical Index (MCI) | | |
|---|---|---|---|
| | N | Mean ± SD | Minimum, Maximum |
| <4.5 | 39 | 0.64 ± 0.12 | 0.43, 0.88 |
| 4.5 – 9.0 | 21 | 0.40 ± 0.12 | 0.22, 0.76 |
| Total | 60 | 0.56 ± 0.17 | 0.22, 0.88 |
| **p-value** | **<0.001 (Significant)** | | |

This table shows that with decrease in metacarpocortical index there is increase in serum phosphorus and it is statistically significant.

**VARIOUS SERUM ALKALINE PHOSPHATASE LEVELS AND CORRESPONDING METACARPOCORTICAL INDEX:-**

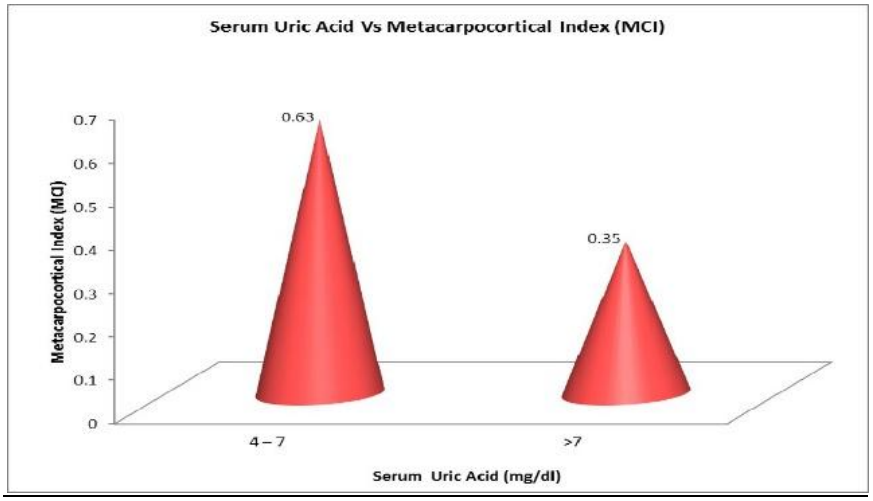



This graph shows that serum alkaline phosphatase increases with decrease in metacarpocortical index.

| Serum Alkaline Phosphatase (IU/L) | Metacarpocortical Index (MCI) | | |
|---|---|---|---|
| | N | Mean ± SD | Minimum, Maximum |
| 60 - 100 | 31 | 0.67 ± 0.11 | 0.47, 0.88 |
| 101 – 150 | 16 | 0.52 ± 0.12 | 0.40, 0.77 |
| >150 | 13 | 0.34 ± 0.07 | 0.22, 0.45 |
| Total | 60 | 0.56 ± 0.17 | 0.22, 0.88 |
| **p-value** | **<0.001 (Significant)** | | |

This table shows there is decrease in metacarpocortical index with increase in serum alkaline phosphatase and it is statistically significant.

**VARIOUS SERUM URIC ACID LEVELS AND CORRESPONDING METACARPOCORTICAL INDEX:-**

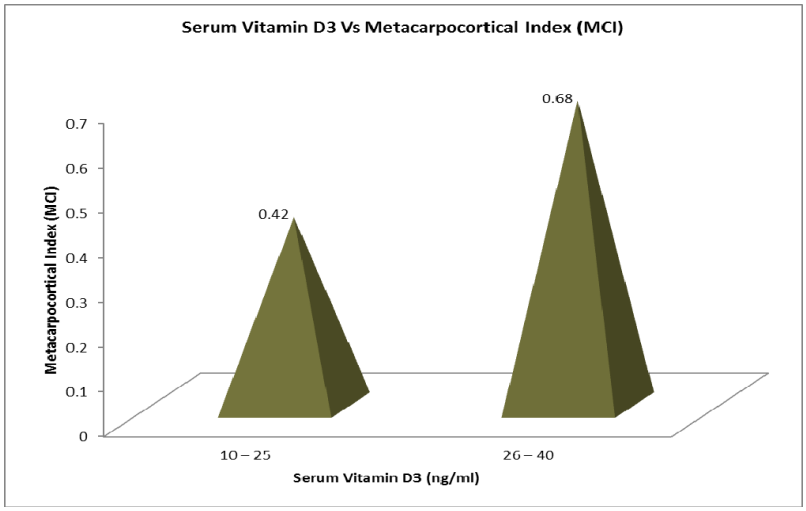


This graph shows with decrease in metacarpocortical index there is increase in serum uric acid.

| Serum Uric Acid (mg/dl) | Metacarpocortical Index (MCI) | | |
|---|---|---|---|
| | N | Mean ± SD | Minimum, Maximum |
| 4 – 7 | 45 | 0.63 ± 0.13 | 0.41, 0.88 |
| >7 | 15 | 0.35 ± 0.06 | 0.22, 0.44 |
| Total | 60 | 0.56 ± 0.17 | 0.22, 0.88 |
| **p-value** | **<0.001 (Significant)** | | |

This table shows that metacarpocortical index decreases with increase in serum uric acid.
It is statistically significant.

**VARIOUS SERUM VITAMIN D3 LEVELS AND CORRESPONDING METACARPOCORTICAL INDEX:-**

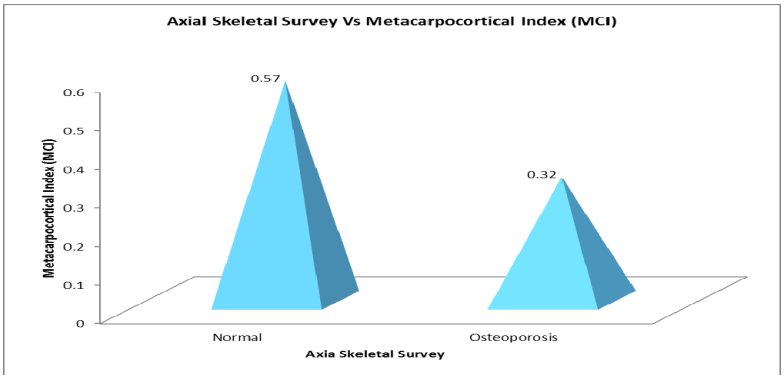



This graph shows as the metacarpocortical index decreases, there is decrease in vitamin D3

| Serum Vitamin D3 (ng/ml) | Metacarpocortical Index (MCI) | | |
|---|---|---|---|
| | N | Mean ± SD | Minimum, Maximum |
| 10 – 25 | 29 | 0.42 ± 0.11 | 0.22, 0.68 |
| 26 – 40 | 31 | 0.68 ± 0.11 | 0.47, 0.88 |
| Total | 60 | 0.56 ± 0.17 | 0.22, 0.88 |
| **p-value** | **<0.001 (Significant)** | | |

This table shows that metacarpocortical index decreases with decrease in vitamin D 3 level and it is statistically significant.

**ANALYSIS BETWEEN METACARPOCORTICAL INDEX AND AXIAL SKELETAL SURVEY:-**




This graph shows with decrease in metacarpocortical index, there is increase in osteoporosis.

| Axial Skeletal Survey – X Ray DL Spine AP View | Metacarpocortical Index (MCI) | | |
|---|---|---|---|
| | N | Mean ± SD | Minimum, Maximum |
| Normal | 58 | 0.57 ± 0.16 | 0.22, 0.88 |
| Osteoporosis | 2 | 0.32 ± 0.07 | 0.27, 0.37 |
| Total | 60 | 0.56 ± 0.17 | 0.22, 0.88 |
| **p-value** | **0.041 (Significant)** | | |

This table shows with decrease in metacarpocortical index there is increase in osteoporosis. It is statistically significant.

## V. Discussion

This study mainly comprises of younger population 18- 50 years in comparison of previous study done by R. G. Henderson et al which had elder age group more than 55 years.

This study was conducted in patients with chronic renal failure to document the renal osteodystrophy by measuring metacarpocortical index (MCI) of second metacarpal bone of right hand and to correlate the MCI index with serum levels of creatinine, urea, calcium, phosphorus, alkaline phosphatase, uric acid, vitamin D 3 and axial skeletal survey. MCI was calculated from 30 persons (control group) both male and female and this mean MCI index was taken as reference and compared with MCI calculated in study group (CRF). The results showing the MCI value in the study group (CRF) (0.42) is declined in comparison with control group (0.69), indicating bone changes . It was 0.38 in case group and was 0.57 in previous study conducted by Dr D. Anil Kumar et al.

The results showed that as the serum creatinine values increases a decline in the MCI was observed in the study group. In patients with serum creatinine more than 15, MCI was 0.28. Whereas MCI was 0.34 in study conducted by Dr
D. Anil Kumar et al.

This study compared MCI in CRF patients with blood urea levels and found the MCI was decreased in proportional raise in the levels of blood urea. Patient with urea more than 200mg% had MCI of 0.26. It was 0.37 in Dr D. Anil Kumar et al.

This study compared MCI in CRF patients with serum calcium levels and found the MCI was increased in proportional elevated levels of serum calcium. Patients with calcium less than 9 had MCI of 0.39. It was 0.38 in study conducted by Dr D. Anil Kumar et al.

This study compared MCI in CRF patients with serum phosphorus levels and found the MCI was decreased with elevated levels of serum phosphorus. Patients with phosphorus more than 4.5 mg/dl had MCI of 0.40. It was 0.39 in study conducted by Dr D. Anil Kumar et al.

This study compared MCI in CRF patients with serum alkaline phosphatase levels and found the MCI was decline with elevated levels of serum alkaline phosphatase. Patients with alkaline phosphatase level more than 150IU/L was 0.34. It was 0.35 in study conducted by Dr D. Anil Kumar et al.

This study compared MCI in CRF patients with serum uric acid levels and found that as the uric acid levels elevated there is decline in the MCI is observed. Patients with uric acid level more than 7 had MCI of 0.35. It was 0.40 in study conducted by Dr D. Anil Kumar et al.

This study compared MCI in CRF patients with serum Vitamin D 3 levels and found the MCI was decreased with decreased levels of serum vitamin D 3 this was not done in previous study conducted by Dr D. Anil Kumar et al. This study found that it was statistically significant.

## VI. Conclusion

This study concludes that

1) Quantitative bone changes in chronic renal failure patients can be measured by calculating metacarpocortical index from second metacarpal bone of right hand by the X-ray technique which is a simple and cost effective method.
2) Comparison between MCI in CRF patients with biochemical parameters like serum creatinine, urea, calcium, phosphorus, alkaline phosphatase, uric acid, vitamin D3 and axial skeletal survey concluded that MCI has been found to be decline with elevated levels of serum creatinine, urea, phosphorus, alkaline phosphatase and uric acid levels and MCI has been in found to be increased with elevated serum calcium levels.
3) X-ray of right hand for calculating MCI from second metacarpal bone can predict quantitative bone changes which is useful in preventing complications of osteodystrophy (ex : fractures).
4) Quantitative bone changes occurring in CRF patients by measuring MCI can be useful in the management and treatment in CRF. Thus MCI is a simple, reliable, non-invasive and accessible method in predicting renal osteodystrophy early in asymptomatic stage and helps in preventing grave complications of renal osteodystrophy by early intervention and treatment.

**LIMITATIONS OF STUDY:-**

1) This study was done with less number of patients.
2) In this study serum paratharmone was not assessed.
3) This is single centre study.
4) There may be inter observer variation in X ray reporting.

## Bibliography

[1]. Dr D.Anil Kumar, Dr B.Srinivas, Dr.S.Prem Sagar A Study of Metocarpocortical Index (MCI) in Chronic Renalfailure Indian Journal of Applied Research, Vol.5, Issue : 7 July 2015
[2]. The importance of the metacarpal bone index in the evaluation of uremic osteodystrophy J ClinDensitom. 2001 Fall: 4 (3) 199 -207, The importance of the metacarpal bone index in uremic osteodystrophy SrpArhCelokLek, 1996: 124 Suppl1:112-4. |
[3]. Metacarpal Bone Mass in Normal Adults and in Patients with Chronic Renal Failure J. Andresen, H. E. Nielsen, T. E. Hansen, L. Bolvig
[4]. First Published November 1, 1981 Hutchison AJ, Whitehouse RW, Boulton HF, Adams JE, Mawer EB, Freemont TJ, Gokal R 1993 Correlation of bone histology with parathyroid hormone, vitamin D3, and radiology in endstage renal disease. Kidney Int44:10711077 | | |
[5]. Rix M, Andreassen H, Eskildsen P, Langdahl B, Olgaard K 1999 Bone mineral density and biochemical markers of bone turnover in patients with predialysis chronic renal failure. Kidney Int 56:10841093. |

M.Rajkumar. "A Study of Metacarpocortical Index in Chronic Renal Failure." IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), vol. 18, no. 3, 2019, pp 62-71.