Comparison of phalangeal bone mineral content and density between the dominant and non-dominant sides

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Abstract

Objectives Compared to the non-dominant side, higher bone mineral content (BMC) and density (BMD) have been demonstrated in the forearm bones in the dominant side. Clinicians are compelled to scan the dominant side when deformities or artifacts are found in the non-dominant side. This study was done to evaluate the differences in phalangeal BMC and BMD, measured using accuDXA, between the dominant and non-dominant hands.

Design and participants A group of 333 subjects, comprising 267 healthy volunteers (185 women and 82 men) and 66 women with rheumatoid arthritis. Phalangeal BMD and BMC, were measured using accuDEXA, both in the non-dominant and dominant hands.

Main results BMC and BMD showed strong correlations between the two sides ($r = 0.95$, $p < 0.001$ for both). Compared to the non-dominant side, dominant side BMC was 5% higher (mean values =1.54 and 1.47, mean difference = 0.064, 95% CI for the mean difference = 0.048–0.081g, $p < 0.001$) and BMD was 4% higher (mean values = 0.480 and 0.463, mean difference = 0.018, 95% CI for the mean difference = 0.014–0.021 g/cm^2, $p < 0.001$). In the subgroup analysis, percentage differences of BMD between the two sides were found to be similar among men (n = 82), women (n = 251), people below 50 years (n = 24), people above 50 years (n = 122) and also among patients with rheumatoid arthritis (n = 66).

Conclusions When the non-dominant hand is not suitable for scanning, the clinician should consider scanning the dominant hand instead. However, the differences in BMD between the two hands should be taken into consideration when interpreting results.

Introduction

Osteoporosis has become a major heath problem in many countries and attempts are being made to reduce the occurrence of fragility fractures. Drugs with proven anti-fracture efficacy are prescribed to patients with increased fracture risk, but quantification of fracture risk in each patient is required before commencing such therapies [1]. Low bone mineral density, measured using dual energy xray absorptiometry (DXA) is predictive of future fragility fractures and is widely used in recognising high risk patients [2]. Although central type DXA has the advantage of measuring BMD in multiple sites, devices which can measure a single site in the appendicular skeleton are also being used to determine fracture risk [3]. These peripheral devices are popular due to their low costs and easy applicability. Phalangeal BMD measured by accuDXA can predict fractures in central sites such as spine [4] and is gaining popularity among clinicians.

When measuring BMD either in axial or appendicular skeleton, the non-dominant side is selected to maintain uniformity. However there are instances where the non-dominant side is not suitable for scanning due to the presence of deformities or artifacts in the region of interest. Previous studies using DXA have shown that there are significant differences in both BMD and BMC between dominant and non-dominant sides [5,6,7]. Whether such differences exist in phalangeal BMD is not known. We decided to perform this study to estimate the differences in BMD and BMC between the dominant and non-dominant sides in order to help clinicians to make adjustments when BMD and BMC are measured in the dominant side.

Method

A group of 333 subjects, which included 267 healthy volunteers (82 men) and 66 women suffering from rheumatoid arthritis, was selected for the study. Both BMD and BMC of the middle phalanx of the third finger were measured using the accuDXA (Schick Technologies Inc), first in the non-dominant hand and then in the dominant hand. All scans were done by a single operator, adhering to the instructions given by the manufacturer of the machine. In vitro calibration of the machine was done daily using the inbuilt software to make sure that the accuracy and precision of bone mineral density estimations were within the acceptable limits. Consent was obtained from each participant before the scanning and approval for the study was given by the local ethics committee.

Dominant hand was defined as the hand they used most of the time when cutting, throwing or receiving things. Five subjects were left-handers and the rest were right-handers. BMD and BMC of the dominant and non-dominant sides were compared using the student's paired t-test and correlations between the two sides were examined using the Pearson's correlation coefficient.

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Percentage differences and absolute differences in BMC and BMD were calculated for the entire group and also for subgroups of all men, all women, subjects below 50 years, subjects above 50 years and also for patients with rheumatoid arthritis. Two tailed $p < 0.05$ were taken as the level of statistical significance and SPSS (version 10) was used for all analyses.

Results

Age of the participants ranged from 20 to79 with mean (SD) of 40.9 (10.5) years. Both BMC and BMD showed significant correlations between the two sides ($r = 0.84$ and 0.95 for BMC and BMD respectively, $p = 0.001$ for all). The dominant side had higher BMD and BMC when compared to the non-dominant side. Compared to the non-dominant side, dominant side BMC was 5% higher (mean difference of 0.064, 95% CI for the mean difference=0.048–0.081 g, $p < 0.001$), while BMD was 4% higher (mean difference of 0.018, 95% CI for the mean difference=0.014–0.021 g/cm^2, $p < 0.001$) (Tables 1 and 2). Percentage differences of BMD were similar in all subgroups (Table 3). Patients with rheumatoid arthritis had lower BMD and BMC but the differences between the two sides were same as healthy females.

Conclusions

This study demonstrates significantly higher phalangeal BMC and BMD values in the dominant side compared to the non-dominant side. The magnitude of the differences was broadly similar among healthy men, healthy women, subjects below 50 years, subjects above 50 years and also among women with rheumatoid arthritis. Further BMD and BMC values between the two sides showed strong correlations. When measuring phalangeal BMD, if the non-dominant hand is not suitable due to the presence of congenital or acquired deformities, the dominant hand can be used instead. However, when interpreting results to assess the future fracture risk, clinician needs to remember the above differences and make the necessary adjustments in the results.

Table1. **Correlations and differences of BMC between the two sides**

	Dominant side BMC (g)	*Non-dominant side BMC (g)*	*Correlation between two sides (r)*	*Mean BMC difference (g)*
Entire sample	1.535	1.471	0.95*	0.064**
Healthy males	2.100	2.020	0.84*	0.080**
Healthy females	1.350	1.291	0.92*	0.059**
Healthy subjects below 50 years	1.710	1.638	0.94*	0.072**
Healthy subjects above 50 years	1.234	1.183	0.90*	0.052**
Rheumatoid patients	1.293	1.215	0.94*	0.078**

* p for correlation coefficient < 0.001
** p for the mean difference < 0.001

Table 2. **Correlations and differences of BMD the two sides**

	Dominant side BMD (g/cm^2)	*Non-dominant side BMD (g/cm^2)*	*Correlation between two sides (r)*	*Mean BMD difference (g/cm^2)*
Entire sample	0.480	0.463	0.95*	0.018**
Healthy males	0.587	0.567	0.92*	0.021**
Healthy females	0.445	0.429	0.93*	0.016**
Healthy subjects below 50 years	0.527	0.509	0.92*	0.017**
Healthy subjects above 50 years	0.399	0.382	0.93*	0.018**
Rheumatoid patients	0.415	0.400	0.91*	0.015**

* p for correlation coefficient < 0.001
** p for the mean difference < 0.001

Table 3. **Percentage differences and 95% confidence intervals in BMD between the two sides**

Category	*% difference in BMD*	*95% confidence intervals*
Entire sample	3.96	0.58 to 7.55
Healthy men	4.16	1.27 to 6.41
Healthy women	3.78	0 to 7.88
Subjects below 50 years	3.92	0.78 to 6.73
Subject above 5 years	4.03	0.12 to 9.12
Patients with rheumatoid arthritis	4.13	–0.54 to 9.17

Mean BMD and BMC values in subgroups were explainable when their age and gender differences were taken into consideration. Men had higher BMD and BMC values compared to women and people above 50 years had lower BMD and BMC when compared with people below 50 years. Patients with rheumatoid arthritis had the lowest BMD, but the difference between the two sides was similar to that of healthy women indicating that the bone loss in rheumatoid patients is more generalized and uniform.

Differences in forearm BMD between the dominant and non-dominant sides have been reported earlier [5–7]. In these studies, BMD or BMC was constantly higher in the dominant side compared to the non-dominant side. Although the exact mechanism of this discrepancy is not known, physical activity appears to be the most likely mechanism [8]. Ducher and colleagues reported these differences to be confined to cortical bone and this too can be taken in support of the role of physical activity as the underlying mechanism [9].

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References

1. Kanis AJ. Diagnosis of osteoporosis and assessment of fracture risk. *Lancet* 2002; **359**: 1929–36.
2. Marshall D, Johnell O, Wedel H. Meta-analysis of how well measures of bone mineral density predict occurrence of osteoporotic fractures. *British Medical Journal* 1996; **312**: 1254–9.
3. Miller PD, Siris ES, Barrett-Connor E, Faulkner KG, Wehren LE, et al. Prediction of fracture risk in postmenopausal white women with peripheral bone densitometry: evidence From the National Osteoporosis Risk Assessment. *Journal of Bone and Mineral Research* 2002; **17**: 2222–30.
4. Ohtsuka M, Michaeli D, Wasnich RD. Relationship between phalangeal bone mineral density and risk of vertebral fracture. *Journal of Clinical Densitometry* 2002; **5**: 11–5.
5. Akar S, Sivrikaya H, Canikli A, Varoglu E. Lateralized mineral content and density in distal forearm bones in right-handed men and women: relation of structure to function. *International Journal of Neuroscience* 2002; **112**: 301–11.
6. MacIntyre NJ, Adachi JD, Webber CE. In vivo detection of structural differences between dominant and nondominant radii using peripheral quantitative computed tomography. *Journal of Clinical Densitometry* 1999; **2**: 413–22.
7. Taaffe DR, Lewis B, Marcus R. Quantifying the effect of hand preference on upper limb bone mineral and soft tissue composition in young and elderly women by dual-energy X-ray absorptiometry. *Clinical Physiology* 1994; **14**:393–404.
8. Nevill AM, Holder RL, Stewart AD. Modeling elite male athletes' peripheral bone mass, assessed using regional dual x-ray absorptiometry. *Bone* 2003; **32**: 62–8.
9. Ducher G , Prouteau S, Courteix D, Benhamou CL. Cortical and trabecular bone at the forearm show different adaptation patterns in response to tennis playing. *Journal of Clinical Densitometry* 2004; **7**: 399-405.