DXA Scan Field Length Does Not Substantially Affect Measured BMD

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ABSTRACT

Obtaining appropriate spine acquisition length (mid L5 to mid T12) may be more difficult when using a fan beam densitometer, compared to pencil beam technology, due to the wide beam width. Based upon clinical observations, we hypothesized that inclusion of more thoracic vertebrae in spine images may decrease measured BMD by including ribs within the "soft tissue."

As such, we obtained spine scan pairs on a GE Lunar Prodigy. One from mid L5 to mid T12, the second, one beam swipe longer. Additionally, to investigate a potential affect of variable tissue thickness due to shorter scan length, paired femur scans, one in standard manner, the second two cm shorter, were also obtained.

Spine and hip scan pairs were obtained sequentially without repositioning on 30 subjects with mean age and weight of 53.0 years and 155 pounds respectively. On standard autoanalysis, 15 had normal BMD and 15 were osteopenic. The mean difference between paired L-spine scans was .006 grams/cm² (range - 0.029 to + 0.017) yielding a mean T-score change of - 0.1 (range - 0.3 to + 0.2). Similarly, no difference was observed between paired femur scans; the mean total, neck and trochanteric BMD difference was 0.002, 0.001, and 0.002 grams/cm². On linear regression analysis, there was no impact of age, weight, height or bone mass on difference in BMD between scan lengths.

Overall, spine and femur scan length has only minimal impact on measured BMD, which is less than most centers' least significant change (LSC). However, in some individuals, L-spine scan length alters measured BMD by an amount that approaches significance. Given this, technologists should strive to reproduce scan length to avoid introducing additional measurement variability. However, interpreting physicians should not feel obligated to request/require that scans be repeated when a longer scan is obtained upon follow-up imaging.

INTRODUCTION

The ISCD bone densitometry certification course and manufacturer training recommends that lumbar spine scans be obtained from the middle of L5 to the middle of T12. With pencil-beam densitometers obtaining scans of appropriate length is not difficult due to narrow beam width and slow scan speed. However, given the rapid, wider sweeps produced by fan-beam instruments, obtaining optimal scan length may be more challenging and "longer" spine scans may result. It is possible that such longer scan length alters measured BMD by including ribs within the "soft tissue" baseline. Additionally, variation in soft tissue around the femur may affect measured BMD. To evaluate this possibility, this study assessed the affect of obtaining longer spine and shorter hip scans on measured BMD.

METHODS

Subjects

- Lumbar spine and proximal femur scans were obtained on 30 adult volunteers (24 F/6 M)
- Age, weight and lowest T-score: mean (range) was 53.0 (20.1 to 81.9) years, 155 (112 to 198) pounds and -0.9 (-2.4 to 1.6) respectively

Densitometers/Data Acquisition and Analysis

- All scans were obtained on a single GE Lunar Prodigy densitometer using software version 6.70
- Two lumbar spine and left proximal femur scans were obtained on all subjects using standard positioning without repositioning between scans
- The initial lumbar spine scan included the middle of L5 to the middle of T12; the second "longer" scan was allowed to proceed one swipe further into the thoracic spine (Figure 1a)
- The initial femur scan was obtained per manufacturer recommendations; the second "shorter" scan was started two cm cranial to the prior start point (Figure 1b)

Statistical Analyses

- "Standard" length scans were compared with "longer" lumbar spine and "shorter" femur scans utilizing linear regression and Bland Altman (Analyze-it, Leeds, UK) analyses

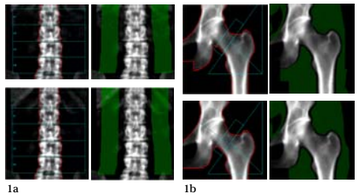
RESULTS

Lumbar Spine BMD Comparison

- The measured L1-L4 BMD did not differ between the "standard" and "longer" acquisition (Figure 2a)
- L1-L4 bias between these two approaches was only 0.006 grams/cm² (Figure 2b)
- The range of differences between paired scans ranged from -0.029 to + 0.017 grams/cm², less than the expected L1-L4 LSC in many DXA facilities
- Linear regression analyses revealed no impact of age, weight, height or bone mass on difference in BMD between the standard and longer scans

Proximal Femur BMD Comparison

- The measured BMD at the total femur, femoral neck and trochanteric region was virtually identical between the "standard" and "short" acquisition approaches (Figures 3a, c, and e)
- Bias at the total femur, neck and trochanteric regions based upon scan length was virtually zero; 0.002, 0.001 and 0.002 grams/cm² respectively (Figures 3b, d and f)
- Range of differences between paired scans at the total femur, femoral neck and trochanteric regions was -0.010 to + 0.020, -.028 to + 0.031 and -0.019 to + 0.019 grams/cm² respectively
- Linear regression analyses revealed no impact of age, weight, height or bone mass on difference in BMD between the standard and shorter scans



1a 1b

Figure 1a/b: ***Examples of "Standard/Long" Lumbar Spine and "Standard/Short" Proximal Femur Scans.*** More rib is present in the soft tissue baseline on the longer spine scans (1a), little soft tissue difference is evident on the femur scans (1b).

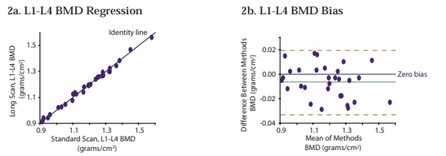


Figure 2: ***Lumbar Spine BMD Comparison; Standard Scan Length vs. Longer Scan.*** Measured BMD was highly correlated $r^2 = 0.994$ and longer scan length did not introduce substantial bias (0.006 grams/cm²) into the L1-L4 BMD result.

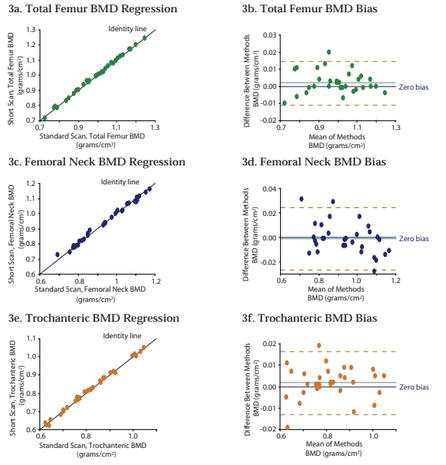


Figure 3a/f: ***Proximal Femur BMD Comparison; Standard Scan Length vs. Shorter Scan.*** Performance of a shorter length scan had essentially no impact on measured BMD at the total femur, femoral neck or trochanteric region ($r^2 = 0.998$, 0.992, and 0.996 respectively). Specifically, bias at these sites was 0.002, 0.001 and 0.002 grams/cm².

CONCLUSIONS

- In this population, longer lumbar spine length does not substantially impact measured L1-L4 BMD.
- "Differences" in measured BMD associated with longer spine scan length are less than commonly reported least significant change observed when conducting precision assessment.
- Similarly, shorter femur scan length does not impact measured BMD at any femur subregion.
- Given the minimal impact of scan length upon BMD, when "longer" spine scans occur, it is not necessary for interpreting physicians to request that imaging be repeated.
- When significant changes in BMD are observed in scans of different length, which are otherwise technically similar, it is improbable that differences are due to scan length and therefore likely reflect a true difference in BMD.