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Barriers to Providing Dual Energy X-ray Absorptiometry Services to Individuals with Spinal Cord Injury

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Abstract

To assess barriers to bone mineral density testing in individuals with chronic spinal cord injury, a cross-sectional study of 20 individuals with spinal cord injury was conducted with assessment of physical and logistical barriers to dual energy x-ray absorptiometry scanning. We identified several barriers including scanner design and configuration in the scanning room that limited accessibility, increased typical scanning time, and made additional staff necessary. In order for dual energy x-ray absorptiometry to become a routine component of ongoing care in spinal cord injury medicine, we recommend the following changes: (1) install ceiling-mounted hydraulic lifts and grab bars to facilitate transfers in the scanning room; (2) increase staffing during scans; (3) increase time allotment for scans, (4) install the scanner in an adequately-sized room, and (5) partner with administrators and staff to raise awareness of access issues faced by individuals with spinal cord injury.

Keywords

Spinal Cord Injury; Osteoporosis; Bone Mineral Density; Fracture

Spinal cord injury (SCI) is associated with severe osteoporosis that increases the risk of low-impact fractures (i.e., those that occur in the absence of trauma).¹ As many as 70% of individuals with SCI will sustain a long bone fracture at some point following their injury with the mean time to first fracture at 9 years post-injury.^{2,3} In post menopausal and senile osteoporosis, most clinically relevant fractures occur at the hip, distal radius, and lumbar spine. In contrast, SCI-associated bone loss and fracture risk are greatest at the metaphyses of the

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distal femur and proximal tibia.⁴⁻¹⁰ Currently, these sites are not included in standardized dual energy x-ray absorptiometry (DXA) protocols designed for osteoporosis screening.

We have been assessing the health of individuals with spinal cord injury since 1994 as part of an epidemiological study assessing chronic health outcomes in chronic SCI.¹¹ Given the lack of SCI patient-specific DXA protocols, in the current study we sought to define barriers to routine bone mineral density (BMD) assessment for individuals with SCI.

Methods

Subjects

Twenty participants were selected from a larger epidemiological study assessing health in chronic SCI.¹¹ These 20 participants were recruited from military veterans with SCI who had previously been treated at our VA Medical Center and from non-veterans living in the community also participating in the parent study. Ambulatory mode and the need for assistance to transfer from a wheelchair to the scanning table were noted at the time of recruitment. The study was approved by our institutional review boards and all study subjects gave informed consent.

Spinal Cord Injury Classification

Motor level and completeness of injury was assessed by physical exam. Level of injury was classified according to strength preservation in key muscle groups in the upper and lower extremity and reported regionally as tetraplegia (cervical SCI) or paraplegia (thoracic or lumbar SCI). ASIA Impairment Scale grade was reported according to guidelines suggested by the American Spinal Injury Association (ASIA).¹² Participants were assigned as motor complete (equivalent to ASIA A or B) or ASIA D.

Assessment of Bone Mineral Density by Dual X-ray Absorptiometry (DXA) Scanning

Bone mineral density (BMD) was determined by DXA scan using a 4th generation General Electric Lunar Prodigy Advance™ densitometer (GE Healthcare Inc., Waukesha, WI), with scans being performed at the hip and knee (proximal tibia and distal femur). Customized research software supplied by General Electric was used to determine the bone density of the proximal tibia and distal femur. Scanning time was considered from the time the subject entered the room to the scan was completed.

Survey of Dimensions of all DXA Machines Approved for Clinical Use

Measurements of scanning machine dimensions (table height, width, and length) were taken manually with a tape measure for the GE Lunar Prodigy DXA densitometer, and the Hologic QDR system used routinely for clinical (Hologic) and research (GE Lunar) purposes at our facility. Room dimensions, including door width, were also measured. These measurements were compared with all models currently approved for use by the U.S. Food and Drug Administration (FDA) and manufactured by General Electric Healthcare (Waukesha, WI), Hologic (Bedford, MA), and Norland (Norland Cooper Surgical Co., Trumbull, CT). Cooper Surgical service representatives were contacted for Norland DXA machine documents, which included the footprint specifications and operator's guide. General Electric Lunar Prodigy™ and DPX™ series dimensions were obtained from the GE Healthcare internet website, and those for the iDXA™ series through the local sales representative. Hologic machine specifications were obtained in a similar fashion, with documentation provided by local service representatives.

Results

Participant Characteristics

The average age for participants was 56.3 (± 12.9 years) with a mean of 20.9 (± 13.1) years since injury (Table 1). The majority of participants (14 of the 20) had paraplegia, 10 of whom were motor complete and 4 were ASIA D. Of the 6 participants with tetraplegia, 3 were motor complete and 3 were ASIA D. Ambulatory mode, defined as mode used more than half the time, included 13 using a hand propelled wheelchair, 5 using a crutch, cane, or similar aid, and 2 walking without assistance. All subjects were living independently in the community at the time of testing and no one came for testing with a personal care attendant.

Physical Barriers to DXA Scanning

We identified several physical barriers to routine BMD assessment in the SCI population. First, the height of the DXA scan table used in this study is fixed at 67.5 centimeters, with a differential between a typical wheelchair seat and the table of 15 centimeters. This height differential is too great for standard sliding board transfers from a wheelchair (see figure 1). We then surveyed the table height of several other commonly used DXA scanners and found this to be a universal issue. Tabletop heights ranged from 66 centimeters to 76 centimeters from the floor (see table 1), and none was capable of lowering to below 66 centimeters. To address the difficulties of transferring from wheelchair to the DXA scanner tabletop, we attempted to have subjects transfer from a stretcher to the table. However, the room where the DXA scanning was performed was too small for easy entry and maneuvering with a stretcher. We also attempted to use a hoist lift for transfers. But, the design of the DXA scanner prevents placement of the lift close enough to the table for safe transfers because there is no space under the table to position the base and legs of the lift. Also, the room size again limited maneuverability of this device. For both DXA scanners at our facility, the room size measured 375 centimeters by 360 centimeters with a door width of 87 centimeters. All 3 manufacturers suggest a smaller minimum room dimension of 244-320 centimeters by 244-335 centimeters. Rooms of this minimum dimension limit entry and maneuverability of stretchers, wheelchairs, and hoist lifts.

Logistical Barriers to DXA Scanning

We identified several logistical barriers to routine BMD assessment in the SCI population. First, to overcome the physical barrier of the tabletop height, we had to have 3 staff members present to assist with lifting subjects from the wheelchair to the scanner table. This is in contrast to typical DXA exams in the general population where patients are able to mount the table unassisted, using a stool if needed, with the presence of only 1 staff member. Second, the average scan time for subjects with more complete and higher SCI levels was between 30 to 45 minutes. This is considerably longer in duration than the average scan time (20 minutes) allocated for DXA exams in the general population in our clinic. This extra time was needed to assist patients during transfer to the tabletop and during repositioning of paralyzed limbs for the scanning of the various skeletal sites. Subjects with good upper-body strength still had difficulty transferring and positioning themselves on the table due to the absence of grab bars above and to the sides of the table.

Discussion

In this study we have reported several physical and logistical barriers to DXA scanning for individuals with SCI. In general, the process of DXA scanning is not well designed for accessibility, and we found no bone densitometer model that is easily adaptable for that purpose. None of the surveyed scanners had a table height that facilitated a level transfer from a wheelchair. Also in the current study room size was a major obstacle. Ideally, room entrances

should open directly to the DXA machine without turns or obstructions, such as computer workstations or furniture. Doorway widths should be a minimum of 86.4 centimeters to accommodate the entry of both manual and electric-powered wheelchairs.¹³ However, the minimum doorway width recommended by both GE Healthcare and Hologic falls short of this.

The barriers identified during this study represent a significant limitation to widespread DXA scanning in the disabled, and particularly, in the SCI population. More broadly, these issues may be applicable to other patient populations where mobility is compromised and osteoporosis and osteoporotic fracture risk is elevated, including individuals with stroke and lower extremity amputees. Until these barriers are systematically addressed on a national level, it is unlikely that bone density assessment will become a standard of care following SCI or other disabling conditions. Osteoporosis is common following SCI and long bone fractures occur frequently post-injury.³ Recent reports suggest that treatment with alendronate may prevent bone loss both acutely and chronically;^{14, 15} however, it is unknown whether alendronate treatment will reduce the fracture rate in this patient population.

Guidelines are currently lacking for the diagnosis, as well as for the prevention and treatment, of osteoporosis in SCI. However, if treatment is to become more common in this population, routine bone density assessment will be needed to gauge its clinical efficacy.

Conclusions

The barriers identified in the current study may represent a significant obstacle to bone density testing in SCI patients on a national level. However, these barriers can be addressed. In order for DXA scanning for SCI patients to become commonplace, we recommend the following changes: fitting of the DXA scanning room with a ceiling-mounted hydraulic lift and grab bars to facilitate transfers, installation of the DXA apparatus in an adequately-sized room, increased staffing during SCI patient BMD scans, increased time allotment for SCI BMD scans, and partnering with administrators and staff to raise awareness of access issues faced by individuals with SCI.

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Figure 1. Photo illustration of a mock patient seated in a wheelchair next to the GE Lunar Prodigy DXA scanner demonstrating a 15-centimeter chair to tabletop height differential making transfers difficult.

Table 1
Relevant Dimensions for Commonly Used DXA Machines and Manufacturer Suggested Minimum Room and Door Sizes

	L (cm)	W (cm)	H** (cm)	Min room L × W (cm)	Min door Width (cm)
GE Healthcare					
IDXA™	302	131	66	320 × 335	81
DPX Bravo™	186	86	81	274 × 244	81
DPX Duo™	186	86	81	274 × 244	81
Prodigy Advance™	263	109.3	66	274 × 244	81
Prodigy Pro™	263	109.3	66	274 × 244	81
Prodigy Vision™	263	109.3	66	274 × 244	81
Hologic					
Discovery™ A	202	110.5	68.6-76.2	305 × 244	76
Discovery™ SL	202	110.5	68.6-76.2	244 × 244	76
Discovery™ W, Wi	202	110.5	68.6-76.2	305 × 244	76
Discovery™ C, Ci, and Explorer	192	110.5	68.6-76.2	244 × 244	76
Discovery™ with Whole Body Operation	202	110.5	68.6-76.2	305 × 244	76
QDR™ 4000	184.2	81.7	68.6-76.2	244 × 244	82
Norland/Cooper Surgical					
Excel™	183	122	73.7	244 × 244	91
XR-46™	270	122	73.7	305 × 305	91
XR-600™	198	127	73.7	244 × 244	91
XR-800™	267	127	73.7	305 × 305	91

** minimum table height