Osteodensitometry By Dual Energy X-Ray Absorptiometry In Senegal

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Citation

S M Badiane, A A Dia, C N Ndiaye, M Mbodji, O Ndoye. *Osteodensitometry By Dual Energy X-Ray Absorptiometry In Senegal*. The Internet Journal of Nuclear Medicine. 2015 Volume 8 Number 1.

DOI: 10.5580/IJNUC.28054

Abstract

The dual energy X ray absorptiometry (DXA) is the standard technique for a non invasive assessment of bone mineral density, it allows the diagnosis, the control of osteoporosis and the prevention of fractures. In Senegal, as in sub-Saharan African countries, osteoporosis is considered as rare. Genetic and environmental factors are used to explain this epidemiological feature. In this context, the dual energy X ray absorptiometry (DXA) has been introduced in Senegal very lately (2003), a long time after this technique has been the subject of several studies which made its practice optimal in the West.

This work aims at making an inventory of its practice in Senegal. Further to the census of the health centres which use DXA, a retrospective, descriptive and analytical study has been done on the medical examinations of 1018 patients over seven operative years between 2003 and 2012, as well on the conditions of practice in those centres.

INTRODUCTION

The dual energy absorptiometry (DXA) is a target measurement of the attenuation of two beams of X- photons with different energies that allows obtaining a representation of bone mineral density. The challenge is to have a diagnosis of osteoporosis whose definition as well as classification used by WHO is based primarily on this biophysical concept. The dual energy absorptiometry (DXA) has a key place in the care of osteoporosis. However, the reliability of the results stands on a set of elements ranging from the equipment to the expertise of the practitioner including the instructions. The quality control is the spotlight that allows a good assessment of this practice.

In Senegal, as in sub-Saharan African countries, osteoporosis is considered as rare. Genetic and environmental factors are used to explain this epidemiological feature. The scarcity of epidemiological surveys in Black Africa explains the fragmentary nature of the information that is currently available. This information is taken from the works done so far in the hospital domain and thereby it is a means of recruitment. In this context the dual energy X ray absorptiometry (DXA) has been introduced in Senegal very lately (2003), a long time after this technique has been the subject of several studies which made its practice optimal in the West. This work aims at making an inventory of its practice in Senegal.

MATERIALS AND METHODS

Further to the census of health facilities practicing the DXA osteodensitometry, three (03) centres were found; they are all based in the Senegalese capital city, Dakar. There were two private structures and one public health centre with a Geriatrics department .These health facilities received patients with a request for examining BMD from various sources.

A retrospective, descriptive and analytical study has been done on the medical examinations of 1018 patients gathered from the three centres over seven operative years between 2003 and 2012, as well on the conditions of practice in those centres. All the patients whose BMD medical examinations were recorded and saved during this period of study are taken into account. The data have been taken from a survey form which had six (6) rubrics namely:

- The status of the structure
- The equipment
- The age, sex, and ethnic group of the patient
- The instructions and the origin of the patients according to the specialty of the consultant
- The techniques and results of the explorations
- The quality control (QC) and the rules of good

practice

RESULTS

Centres of exploration and demographic data

All in all, in Senegal three centres have practiced DXA Osteodensitometry during the period of our study from 2003 to 2012. There were two private polyclinics and one public health centre which had a Geriatrics department.

Each centre had one functional machine. Three (03) machines of different trademarks have been noticed:

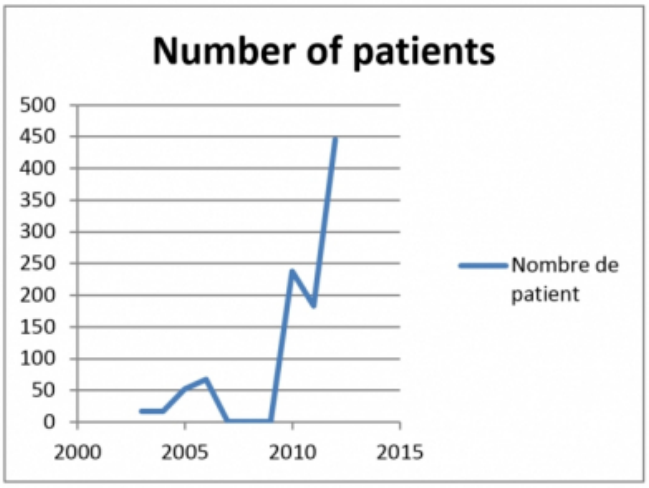
- A machine of general electric, trademark LUNAR/DPX manufactured in 2000
- An Osteolysis/DexumT machine trademark STRATOS manufactured in 2010
- A STRATOS machine manufactured in 2009

The average age of these three machines was 6, 33 years.

In the three (03) centres, 1018 patients were diagnosed over 07 years of actual activities between 2003 and 2012 with 03 years of inactivity from 2007 to 2009 due to a lack of functional equipment in all the centres. Taking into account the years of actual activities only, we observed an average of 145 patients per year. The patients were mainly Black African (85 %) with a progressive profile of the number of patients per year in the growing group.

Figure 1

Progressive profile of the number of patient/year

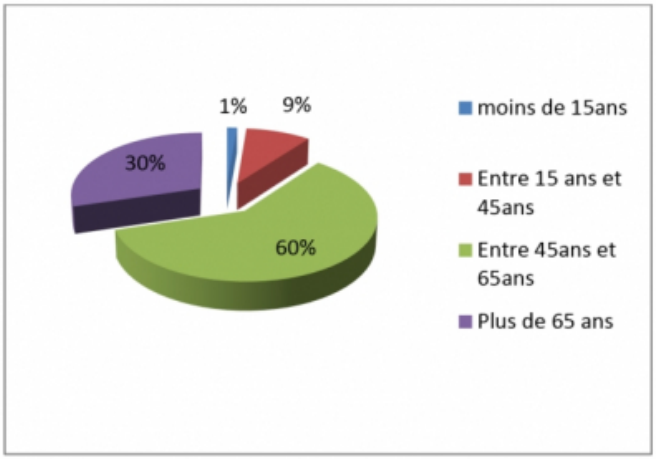


The sex ratio was 4, 5 in favour of women.

The median age of patients was 57, 2 with two extremes ranging from 02 years to 98 years. The average of age was 59, 97 years.

Figure 2

Grouping of the patients according to the age



Instructions

- 55 % of the instructions concerned a post-menopause check-up
- 22% concerned a check-up of genetic disease
- 9% were a pre- therapeutic check-up
- 14 % of the instructions were related to other check-ups that suspected bone fragility (corticotherapy for long short, non traumatic fracture) and bone aches. This rate includes also all the patients who had BMD prescribed and performed even if no precise instruction has been given.

Profile of the Operators

In the different centres, the operators were made up of radiologists, rheumatologists, general practitioners, and senior technicians in medical scanning. At most we found three (03) practitioners working in the same centre, all these operators said to have been trained on the practice of DXA osteodensitometry. The interpretation of results was always made by doctors in those centres. However none of the practitioners questioned had done the test of reproductibleness of in vivo measurements while this test should be part of their phase of apprenticeship and handling of their DXA machines. Among the six operators recorded only one affirmed that he had a certificate of training on the radioprotection of patients.

Consultant

- 35% of the des prescriptions came from general practitioners
- 33% from rheumatologists,
- 13% from orthopeadists,
- 8% from internal medicine
- 6 % from urologists,
- 5% came from other and various specialties.

Techniques and results of the explorations

--Reference Curves

As for the subject from a black ethnic group which consisted of 85% of the patients, two types of reference curves were used in the different centres, the Black American curve in two centres and the Caucasian curve in one centre.

--Sites of measurements

We found the following sites of measurements;

- Rachis + femur 95%
- Rachis only 2%
- Femur only 2%
- Entire body 1%

Other sites and techniques of measurements (upper end of the arm, wrist, VFA) were not practiced.

Profile of the results

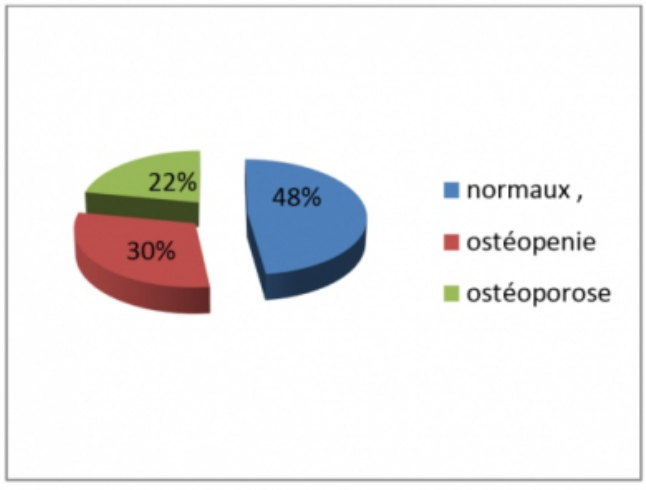
The profile of the results that were found was based on the T-score analysis for the post-menopausal woman and the man aged of more than 40 years; and on the Z-score analysis for the child, the premenopausal woman and the young man.

The results for osteodensitometry for 1018 patients recorded in the three centres revealed:

- normal, 48%
- osteopenia, 30%
- osteoporosis. 22%

Figure 3

Profile of the results



Quality control and rules of good practice:

The quality control at the installation was carried out by the manufacturers. The controls of stability were made at varying periods and intervals from one centre to another:

- Daily control of stability in two centres
- Weekly control of stability in one centre

The reports were not sent to any institution referent. In terms of radioprotection, the regular poster which is usually located on the door of the rooms where ionizing radiations are used was found at the exploration room for the three (03) centres. The distance between the machine and the operator was superior to 02 m in the three (03) centres.

The surface of the rooms (≥ 9m2) and the equivalent lead (≥0,5mm) in terms of thickness for the walls were suitable.

In the three (03) centres, operators did not wear dosimeter.

DISCUSSION

Introduced in clinical practice by the 1980s bone densitometry to DXA, is a biophysical technique developed from the work of Stein [7]. Today it represents the standard method for measuring bone density [12]. It plays an important role in the treatment of osteoporosis.

Our study has shown that its practice has started in Senegal in 2003 after this measurement technique has been the subject of several scientific studies which made its practice optimal; hence the need of an inventory. Furthermore, a few studies on DXA osteodensitometry were found in Black Africa, where osteodensitometry is not a public health priority because it is not considered as prevailing. The Hospital prevalence found in our study was 22%. Yet it does not allow defining the epidemiological profile of osteoporosis in Senegal, especially as bone densitometry was accessible only to a small number of people with 03 centres in the same city for 12,873,601 inhabitants [2].

In a Cameroonian study, for a cohort of 367 women (recruited consecutively), it was found 13.6% of osteoporosis, 46.6% osteopenia [4] for ultrasound measurements. Indeed, Osteoporosis is increasingly rare in Black Africa but it's the studies conducted in the United States that show this feature among Americans from black ethnic group. The latter have a higher bone density than the patients from white ethnic group even at advanced ages [16]. In the same spirit Naudi et al thought that the low incidence of hip fractures in Guadeloupe would be linked to genetic and environmental factors related to the African origins of this population [10]. This genetic viewpoint of osteoporosis

reveals the inadequacy of the Caucasian reference curves for black African populations as observed in this study.

The sex ratio in Senegalese centres was 4.47 for women. This female predominance varies from one country to another (2.8 in France, 2, 01 in USA, 2, 1 in Morocco) [8, 9, 13] as osteoporosis is for most cases a disease of postmenopausal women.

The criteria of prescription for BMD are not codified in Senegal. This codification also defines the conditions of refundability of the deeds by the institutions of sickness insurance. Medical coverage is only available for 18% of the Senegalese population [17]. For this purpose, the indications we found and which were based on the elements transcribed on the patients' sheets of examination were inaccurate. 55% were labelled "post-menopause check up" without any other additional information. In France, AFSSAPS' decision of April 22nd 2005 is a good benchmark in terms of the accuracy of the requirements for the prescription of DXA osteodensitometry [15].

However, it concerns some criteria that can be reviewed and adapted in different contexts. In fact, a French study on the description of practices in terms of osteoporosis diagnosis and care on 1807 persons who benefited from the DXA osteodensitometry showed a decrease of 84.7% for the number of deeds repaid between the first semester of 2007 and the second semester of 2009 over the total population of independent social scheme [5].

Even if osteoporosis is by excellence the pathology of post-menopausal woman and the elderly patient, it can affect a child. There is no current relationship between the risk of fracture and the value of bone density for children [14]. The number of examination found for children under 15 years old is low, about 1%.

The profile of the operators was varied as the most important was that the technical training should remain one of the conditions that ensure the quality of the examinations; as well the training in the interpretation of examinations' results could only be performed by physicians. Although all operators claimed to have been trained, there is no institution to date that provides training in the practice of bone densitometry in Senegal. This makes difficult the access to training and capacity building for practitioners. Competence in Radiation Protection is also an obligation for operators even if the examination is very weakly irradiating [12]. This aspect is rarely taken into account as far as the practices observed are concerned.

The lack of practice for in vivo measures' tests of reproducibility in the handling of the machines, which is an element of quality control, is a deficiency. Each densitometry centre has to evaluate its own in vivo measurement reproducibility. In a particular centre, the in vivo procedures must be established for each machine, and each operator.

Between 2003 and 2012 prescribers in Senegal were made up of 35% of general practitioners, 33% of rheumatologists, 13% of orthopaedists. In Morocco, a study on the epidemiology of osteoporosis showed that most prescribers to DXA bone densitometry were rheumatologists (80 %) [8]. Osteoporosis, without prejudging the aetiology, is a disease most often cared by Rheumatology department. However, Senegal has a small number of Rheumatologists.

The measurement sites found were on the Rachis and the Femur in 95 % of cases. Indeed according to the recommendations, the indirect assessment of bone density should be conducted on two sites: the lumbar rachis (including at least three vertebrae) and the upper extremity of the femur [12].

The interpretation of results beyond the measurement sites is based on reference curves adapted to each type of population. The lack of local reference curves is a limiting factor for optimal results. To date, the Afro-American curve seems to be the most valid for the black population. However, in practice our study revealed the use of the Caucasian curve for subjects from a black ethnic group in one of the centres. The results of BMD for a given patient are not particularly interpretable only if they can be compared to reference values.

This requires having a control population, taking into account many factors in particular:

- The site of measurement
- The sex
- The age
- The ethnic group
- The morphology
- The model of densitometry machine and the manufacturer
- The version of the software. [6]

Osteodensitometry should be performed only when the optimum technical conditions for its realization are met; these are the terms. Prior to the execution of osteodensitometry, it is essential to check the metrological

characteristics of the machine and ensure that the basics of validated references for the sites, age, sex, and the people concerned are available for the interpretation of results. [12]

The reliability of DXA BMD results is based on another important parameter; the quality control which is one aspect of quality assurance. It is a process which aims at determining if what we do is in accordance or not with the specifications or requirements, with established standards. The three BMD centres in Senegal have carried out controls at different times and intervals which vary from one centre to another. This control is based on the ISO 9001-2008 recommendations which requires the measuring machines to be calibrated before their use and to be tested at regular intervals. The user is compelled to make the stability control every day that an examination is carried out on a patient and at least three times a week excluding holiday periods. [3]

Quality assurance also depends on the QC of examinations hence the interest of a good command of the gestures for making the exploration; it is also important to have at hand the manufacturer's manual which is the only reference tool for the correct positioning of the patient according to the machine. During our study, all manufacturers' manuals were found in the different centres at hand for operators.

Compliance with radioprotection standards on any machine using ionizing radiations is also a factor for quality assurance. Still, the DXA bone densitometry cannot be a problem in radioprotection. The dose given to a patient during an examination is to the order of the natural radiation at least 1000 times weaker than X-ray Tomodensitometry. The radiation is low for both the patient and the manipulator if it is placed at more than 02 m far from them.

[1]. In the different centres in Senegal, the manipulators were not wearing dosimeters. Nevertheless, the operator - machine distance exceeded 02 m at all centres. Other parameters such as the lead equivalent for the thickness of the walls, the size of the rooms were respected although the regulatory placard usually affixed on the doors of the rooms where ionizing radiations are used has been found only in one room out of three.

CONCLUSION

Among the techniques for measuring bone mineral density, dual energy X-ray absorptiometry is the most used. Faintly radiant, non invasive, reproducible, and with rapid implementation, it allows to measure bone density on the usual sites of osteoporotic fractures: forearm, rachis, upper extremity of the femur.

It is to date the gold standard for measuring bone mineral density, which, associated with predisposing factors allows the assessment of the risk of fracture in the short term.

According to the the results of this study, it appears that the practice of DXA osteodensitometry in Senegal is growing.

Furthermore, after about ten years of unframed DXA osteodensitometry practice in Senegal, together with the lack of reliable epidemiological data for Black West African populations, the diagnosis and treatment for osteoporosis could not only be based on the results of this modality. To this end, the respect of the rules of good practice is essential. This could pass by consensus during multidisciplinary meetings of dialogues to harmonize and optimize the practice of dual energy DXA osteodensiometry in Senegal.

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