RADIO-NUCLIOTOIDES IN ORTHOPAEDIC DIAGNOSES

ESSAY

SUBMITTED FOR PARTIAL FULFILLMENT OF MASTER DEGREE

IN ORTHOPAEDIC SURGERY

BY

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M.B.B.CH.

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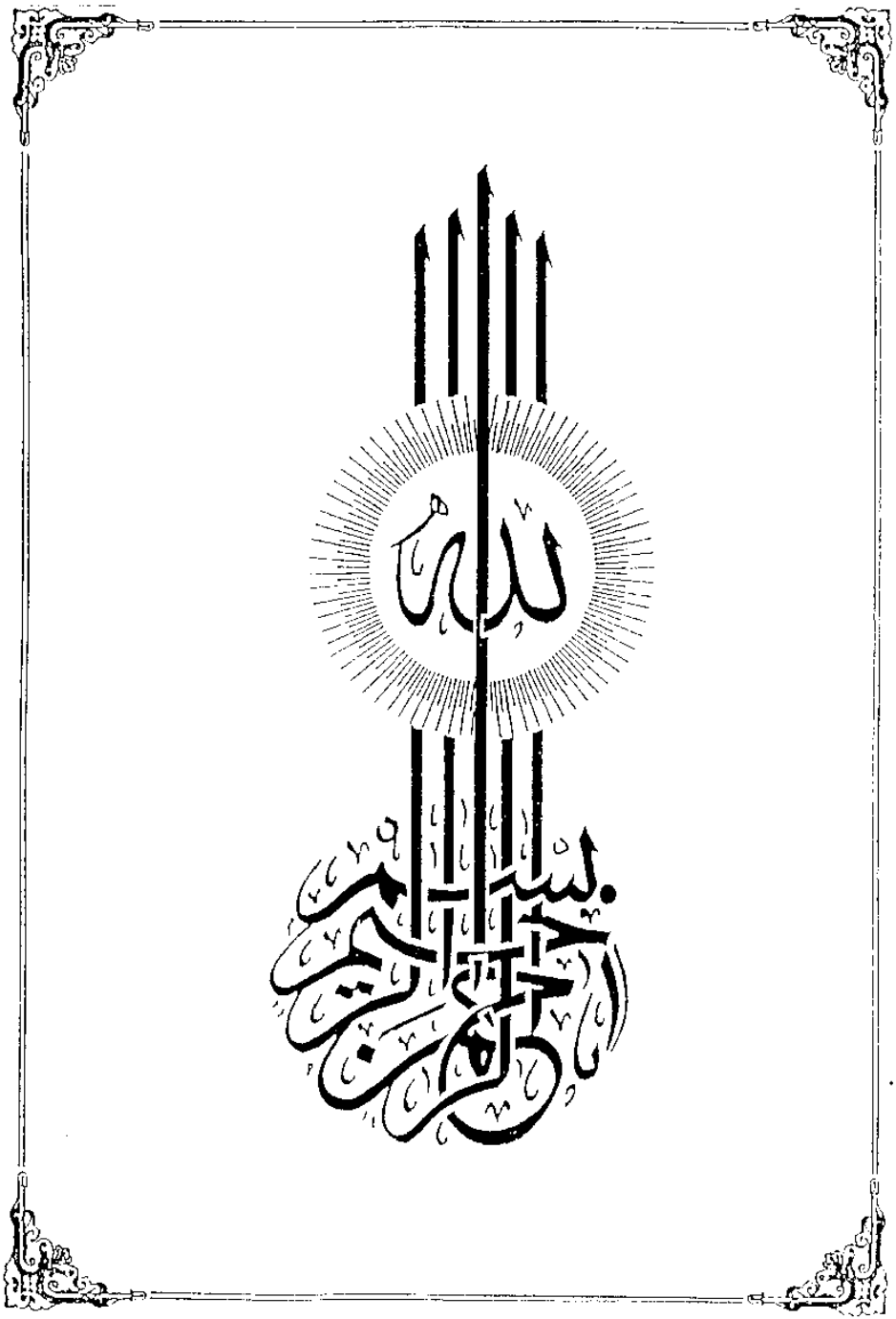

وَقُلْ رَبِّ زِدْنِي عِلْمًا

Index

ACKNOLDGEMENTS

It is very gratifying to be able to appreciate my deepest gratitude to *Prof. Dr. Nabil Hashem,* Prof. of Orthopaedic Surgery, Faculty of Medicine, Ain-Shams University, for his kind supervision, Tactful guidance and valuable advices extended to enable me to do the present study.

I am deeply indebted to *Prof. Dr. Sameh Ahmed Shalaby,* Assistant Prof. of Orthopaedic Surgery, Faculty of Medicine Ain-Shams University for his fine help, continuous encourgement and guidance throught this work.

It gives me great pleasure to have the opportunity of acknoldging all the staff of orthopaedic surgery of Ain-Shams University and to all my collaegues for their help while preparing this work.

Introduction

INTRODUCTION

Numerous diagnostic imaging techniques may be used to supplement the history, physical examination, and labaratory tests in evaluation of bone and joint abnormalities. The decision as to which imaging techniques should be orderd? and in what sequence should be based on? The sensitivity, and specificity of the technique for a particular proplem, as well as avilability, cost, and risk of the technique.

The goal is to make a confident diagnoses in the shortest period of time at the least cost, and risk to the patient.

Radionuclides play an important role as a diagnostic tool in the armamenterium of the orthopaedic procedures are currently available for use either in the clinical evaluation or in the research of orthopaedic proplems. These include neutron activation analysis, radionuclide bone densitometry, calcium kinetic studies, bone scintigraphy, and bone scintimetry.

Radionuclides in orthopaedics provide basic information regarding both anatomical structure and function of the skeletal system. In order to achive this

it is necessary to adminster to the patient - intravenously- a selective bone radiopharmaceutical, then detect its distribution within the skeletal system by means of an external imaging device. The latter can be either a moving detector device (rectilinear scanner) or stationary detector device (Anger scintillation camera).

Radionuclides are a valuable diagnostic tool that is gaining acceptance for the detection of malignant metastases. In addition, this image can be useful in the detection of primary bone tumors, Osteomyelitis, certain trumatic and metabolic disorders involving bone that may not be clearly delineated by conventional radiographs.

The recent increased use of radionuclides bone imaging is attributable not only to its role in diagnoses of skeletal abnormalities, but also to significant technologic improvements in both scanning agents and imaging equipments.

The isotopes in common use are : Methylene diphosphate (99m.tcMDP). and ethyl-hydroxydiphosphonate (99mEHDP). Diphosphonates are compounds of carbon and phosphate, which are rapidly cleared from the blood, producing high bone to soft tissue ratios and marked

accumulation within areas of bone pathology within 2-3 hours of injection.

Bone scanning detect physiological changes in the bone as compared with anatomical changes on plain roentgenograms.

Increased uptake of the radionuclides reflects augmented bone blood flow which can result from numerous causes including, infection tumour, fracture, or even synovitis.

Thus although bone scanning is sensitive in detection of bone abnormalities or joint abnormalities, it is non specific and has to be correlated with radiographs, and clinical findings.

Bone scanning is indicated when there is bone or joint pain and plain roentgenogram prove negative or inconclusev .

It is most useful in diagnosing early osteomyelitis, stress fractures, non displaced traumatic fractures, avascular necrosis and metastatic diseases as a source of undiagnosd pain.

HISTORICAL REVIEW

In 1736, the english surgeon, *John B. Belcher,* observed that the bones of chickens which had been fed on a madder root became red in colour. This observation lead to the understanding that bones was metabolically active, and in the early 1800's a working hypothesis was formed concerning the kinetics of bone in health and disease. Subsequent technical advances have provided a wide variety of tracer techniques for study of bones *(Goran 1965).*

The first labeling of bone tissue by radiotracer was performed by *Chiewitz* and *Hevesy (1935)* in the Niels Bohr Institute, Copenhagen, were adult rats were labeled with ^{32}P-phosphate. This altered the conception that skeletal tissues was metabolically inactive. Radioisotopes of calcium and strontium have lend themselves nicely to the study of calcium turnover throughout the body and in bones specifically. In 1941 the concentrations of calcium 45 and strontium 89 were demonstrated in bone tumours, and attempts were made to use radionuclides as a therapeutic agents. Since then radioisotopic tagging methods have been used to study bone metabolism in normal and many diseased states. The specific in vivo detection

of tumour sites was first done by hand proke scanning in 1959 *(Bauer et al. 1959).*

Radioisotopes of gallium were studied for their tendency to localize in primary and metastatic bone tumours. These radionuclides were also employed as possible therapeutic agents *(Dudley 1950)* and *(Mulry 1951)* in the late 1940's, and in the 1950's. Although the intravenous use of radionuclides of calcium, strontium and gallium was established as an inadequate approach to the treatment of tumour in bone, the differential concentration of radioactivity in the lesions was recognized as a powerful diagnostic tool.

Strontium- 85, with its relatively good imaging characteristics but higher radiation dosage, was used for obtaining bone scans in patients with known malignancy and became the standard bone imaging agent of the 1960's. *(Charkes 1966, Charkes 1968, DeNardo 1966, Fleming 1961, and Rosenthal 1965).* As with gallium 68, the strontium 85 bone scan detect the metastases before the lesions were delineated radiographically *(Wirtanen 1966).* Although bone scintigraphy with strontium 85 was cumbersome, it was used to delineate portals for irradiation therapy, *(Sklaroff 1967),* in determining the extent of primary

bone tumour involvement prior to amputation, and in searching for metastatic bone involvement *(Simpson 1965)*.

The introduction of 99m-technetium labeled phosphate complexes, *(Subramanian and McAfee 1971)* marked a great advance in bone scintiscanning which had so far been reserved for only few laboratories and had not yet become a procedure that could be used as a routine in daily clinical practice, due to the variable stability of the preparations.

The radionuclide 99mTc is ideal for diagnostic purposes. Before 99m technetium can be labeled on any of the phosphorous compounds, it must be reduced to $Tc^{(4+)}$, *(Subramanian and McAfee 1971, and Cox 1974)*.

In general, it may be said that the percentage quality of the administered bone seeking isotope that lablels skeletal tissue does not differ much for the various agents, while the phosphonate complexes, in particular, have a rapid plasma clearance and thus, within the same time interval, a lower blood background *(Kirshnamurthy et al. 1974, 1975)*. Besides, these agents are not taken up by soft tissues, e.g. liver, as are the condensed phosphate complexes.