DIRECT RADIOGRAPHIC MAGNIFICATION IN SKELETAL DIAGNOSIS

THESIS

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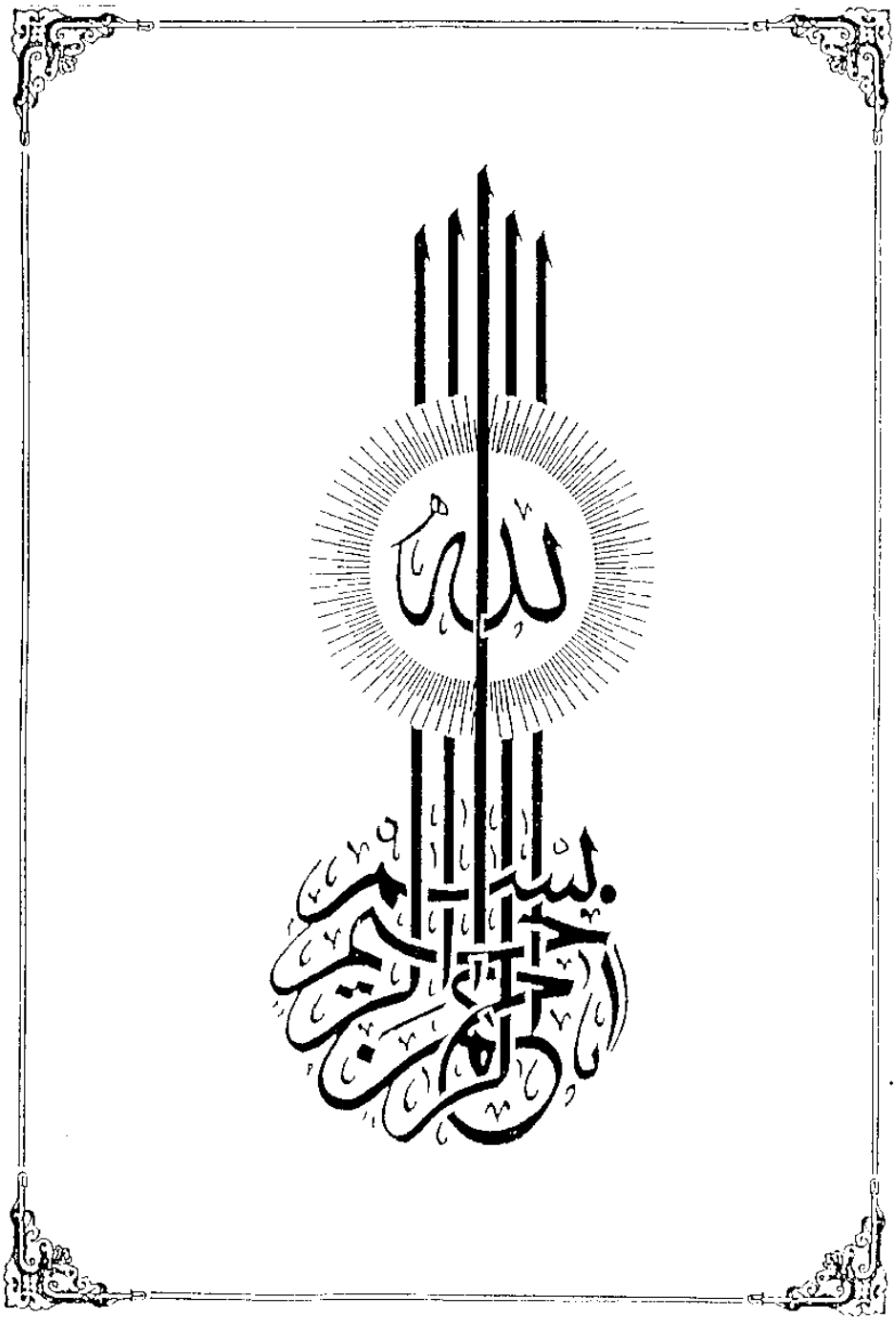

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INTRODUCTION AND AIM OF WORK

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There are two ways of obtaining magnified image on roentgenograms. One is the method of first taking a clear and sharp roentgenogram and having the image enlarged optically, or indirectly. As the applicability of this method to clinical medicine is limited, indirect, magnification roentgenography is not described here.

The other method is based on the object being placed midway between an x-ray tube with a small focal spot and the x-ray film. As the x-rays diverge, a magnified image is obtained directly on the x-ray film. This method is simple in technique and provides rich and significant findings for diagnosis, (Takahashi Sakuma 1975).

High resolution radiography for the detection of subtle changes in the peripheral skeleton may be performed by two different magnification techniques. Optical magnification and radiographic magnification. A comprehensive comparison of both methods to compare the imaging performance and clinical results using both technics was done by (Kunio Doi, Harry K. Genant, M.D., and Kurt Rossmann, Ph.D. 1976).

In other countries an x-ray tube with 0.1mm focal spot has also been manufactured very recently and the clinical value of magnification radiography, has been confirmed.

Macroradiography by definition in a radiograph is directly related to the size of the tube focus and to the relationship in distance between the tube focus, the subject and the film (Clark 1960).

However, Clark made direct radiographic enlargement possible by the provision of a fine focus tube having a 0.3mm square focal spot. At it's best, such a tube will allow high definition enlargement up to 3 times.

Joseph J. and Bookstein, M.D., and Erich Voegeli, M.D., 1971, had done their work on magnification radiography employing a nominal 0.3mm focal spot, 2 times magnification, and an air gap reduction of scatter provided a more than 2 fold increase in line pair resolution, in comparison to standard techniques using a 1mm focal spot. When the smaller focal spot and a rotating grid were combined, resolution was practically equal to

2 times magnification when the magnification process was performed, using 100mA. Image quality was further enhanced by 2 times magnification when 50mA was used. Air gap reduction of scatter offered no advantage over rotating 8:1 grid.

As for Joseph J. Bookstein M.D., and T. Jordan Powell, M.S., their main work was to show that magnification radiography increase line pair resolution by more than 100% compared to standard radiography due to small focal spot, the elimination of the line images seen with a stationary grid, and the magnification itself. Air gap reduction of scatter is not essential with this technic, indeed it seems to be slightly inferior to a rotating 8:1 grid in this respect. They had employed a grid to reduce scatter during magnification radiography to a limited degree. Their current method involved the use of a short target film distance and a rotating grid for convenience, they called it Short Target Film magnification (STF).

Recent advances in technology have made radiographic magnification of the skeleton clinically feasible. A new electron gun microfocal tube combined with new high-resolution recording

systems were used to perform magnification radiography which was then compared with conventional contact radiography. Quantitative evaluation include measurements of speed, contrast, resolution and noise. Qualitative evaluation included an analysis of 2/5 clinical cases in which both techniques were used. The superior image quality of direct radiographic magnification is confirmed and the clinical areas in which it proved most helpful are defined (Harry K. Genant, M.D., 1977)

Dr. M. Langlotiz T. Lanprecht (1980) described in detail a simplified technique, suitable for orthopaedic radiography. The greater information obtained from magnified exposures, as compared with standard exposures was demonstrated by numerous examples. The measurably better image quality of magnification exposures results principally from the increased object-film distance and from the small field size - high degree of collimation - generally used which leads to such a reduction in scattered radiation that an anti-scatter grid can be dispensed with even in the case of relatively thick objects. The importance of the fine focus lies mainly in the fact that it reduces the geometrical unsharpness to be

expected with an increased object film distance to the minimum. The optimum degree of magnification is a function of tube characteristics (focus loadability), the type of object (radiation scatter), the exposure data and the imaging system (film, screen). The factors with the greatest limiting effect on the degree of enlargement are the relatively low. Loadability of the fine focus tube and the resulting need for small focus film distance.

As the maximum degree of enlargement cannot in any case be used, the requirements for equipment and examination technique become simpler, so that the examination can be carried out on a normal orthopaedic-focus tube with a focal spot of less than 0.3mm. Combination of the fine focus with a focus of a normal size provides an x-ray unit which meets all requirements for standard orthopaedic examinations. More than 500 examinations with radiographic enlargement have been carried out in the x-ray compartment of Balgrist Orthopaedic University Clinic between 1st September 1976 and 1st September 1979. The examinations were carried out in patients of all ages, were principally concerned with osseous disease involving changes in the bone structure.

In more than two thirds of all cases the final diagnosis could be confirmed by histological examination (Tumours, Osteomyelitis), by other diagnostic methods or by the clinical course of the disease.

THEORETICAL CONSIDERATION

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If the early stages of any disease begin with the involvement of small area of cells or tissue, the early diagnosis of pathologic changes by means of radiography should concentrate first on the detection of such minute changes. The ideal solution would be to produce x-ray images of findings much finer than those observable by the naked eye, and herein lies a new field of research that is believed to be with developing.

The introduction of a 0.3mm focal-spot rotating-anode tube about 25 years ago opened the way to the clinical application of magnification radiography.

In 1952 an x-ray tube with a 0.15mm focal spot was produced, by reconstructing an existing an existing fixed-anode tube. This x-ray tube has been improved step by step, so that tubes with focal spots of 0.1mm or 0.05mm are now available in Japan. Thus it has become possible to obtain 4 to 6 X magnification images of minute lesions that could not be imaged by normal roentgenography. (Takahashi Sakuma 1975)

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The aim of our work in this Thesis is to show how interpretation of magnified x-ray pic-tures show special features that are not seen in the normal roentgenograms. Next we will describe in detail Techniques necessary for satisfactory magnification radiography.

Finally, we discuss the actual interpretat-ion of the finer parts of the body as revealed by magnification radiography on the basis of a comparison of x-ray images taken clinically by both normal roentgenography and magnification radiography.

MATERIALS AND METHODS