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# Some research possibilities in diagnostic radiography

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## Abstract

Although scientific method is usually viewed as starting with hypotheses which must then be exposed to experimental test, there are situations where this rigid scenario is inappropriate. Fortunately, the alternatives provide avenues for valuable investigative work in radiographic research. Research questions may be addressed by collecting data from existing sources in a way that not only provides fundamental information about human biology, but may improve the efficacy of radiographic practice while avoiding ethical problems about the use of patients. Among those involved in osteology, it is radiographers who see and store the most bone images. Subsequently, they have access to more osteological information than anyone else. All that remains is for this information to be extracted and put into a more accessible form. Since they are closely involved with the patients from whom their radiographs stem, there are research questions which radiographers are uniquely situated to raise.

## Introduction

With the expansion in further and higher education over the last decade, there has been an increased interest in the pursuit of research from many quarters. Radiography, as a profession which has moved over to degree-based education and training during this period, is still developing research niches, [1] with some centres still clarifying their fields of particular interest. A cursory inspection of some of the more recent radiographic literature suggests that much of the current research interest tends to lie in the area of qualitative research, with active advocacy from some quarters [1]. This is not surprising as quantitative research is often seen as beginning with a hypothesis (or a 'hunch ... [as to] a possible solution to a problem' [2]) and since hypotheses (in accordance with the views of Karl Popper [3, 4]) are only meaningful if falsifiable, some form of experimental test must follow. For radiographers working with patients, this is usually viewed as being

difficult for, except under the strictest controls, 'patients' and 'experimentation', quite rightly, do not belong together. However, not all experiments are like this and the nature of scientific research in the particular context of radiography needs not only to be clarified in the light of scientific research in general, but also in terms specific to the discipline. By looking to those who have undertaken research successfully and, importantly, have paused to analyse the intellectual processes adopted, it will be possible to put emerging research on a firmer logical basis. At the same time, by looking at the sometimes meagre facilities available to such workers, it can also be seen that the facilities that are available to radiographers, that is their very stock in trade, at least rival those of many centres of research excellence.

In all cases, however, research begins in the minds of those who ask new questions. Such constraints as there are, at this stage, are only those imposed by the questioner's own intellect, whereas later on, when it comes to the practical exploration of these questions, external influences generally dictate that research take a clearly pragmatic form. Rather than constricting the researcher, this pragmatism can prove to be the source of novel approaches to the question set. By looking at some of the intellectual and pragmatic elements of research which suit a radiographic context, new research possibilities in diagnostic radiography may become apparent.

### **Medawar's four experimental types**

The Nobel laureate Sir Peter Medawar [5, 6] described a total of four different types of experimental process, giving each a graphic name. Those which he called critical (or Galilean) experiments are those with which we are perhaps most familiar, being set out to test, as Medawar describes it, 'the logical consequences of holding' a hypothesis or 'preconceived opinion'. Of the other three types, two have a place in scientific enquiry. These are inductive (or Baconian) experiments, typified by asking, 'I wonder what would happen if ... ' and deductive (or Kantian) experiments typified by, 'Let's see what happens if we take a different view'. Although both ways of thinking are common in practice, few are aware that they might be classed as experimental processes.

Medawar suggests that most original research begins with inductive experiments when we, in effect, say to ourselves 'Let's find out in a bit more detail what it is we are actually studying' and embark on some form of preliminary investigation. Alternatively, deductive experiments, which may also be described as 'thought' experiments, do not require the collection of new data, as here extant data may be re-evaluated from alternative perspec-

tives. Indeed, the very nature of data encourages such experiments since, to have any meaning, data must be interpreted in the light of current understanding and whereas data, once gathered, does not change, that which constitutes 'current understanding' is not necessarily fixed. Any available data may, therefore, be legitimately reappraised in the light of new ideas.

The fourth type of experiment, demonstrative (or Aristotelian) experiments, are those which have been used to convince people of the truth of a preconceived (previously untested) notion. Classroom demonstrations of known processes may be suggested as being akin, although not identical, to this sort of experiment.

### **A familiar problem**

All radiographers are familiar with the problem of 'subject types', where individual differences in a patient's physical characteristics can mean that standard radiographic technique does not produce the expected result, even to the extent that the examination must be repeated. Although 'Clark' [7] provides some guidance on this, the true extent and significance of human variation as applied to diagnostic radiography has received relatively little investigation. Yet this would be a fairly simple 'Baconian-type' experiment. To enhance the accuracy and efficacy of a range of radiographic examinations, simple measurements and observations about surface anatomy could be taken during routine radiography which could then be related to the internal anatomy as portrayed on the resulting radiograph. Data such as these need not impinge upon the patient in any ethically sensitive way. Using a quantitative approach such as this leads, in effect, to qualitative effects in providing a greater focus on the individual needs of each patient and how to provide it.

When one's aim is to benefit the patient, questioning standard radiographic technique is not a case of being radical, rather it is a case of continual testing and reappraisal. Failure to produce some of the more complicated skull radiographs, for example, may reflect more on the individual characteristics of the patient than on the radiographer's ability [8]. Although derived from much careful work, some of the techniques used in the radiographic examination of the skull date from early in this century when only basic equipment was available (for example: Stenvers [9, 10]). Not only was radiography an undeveloped professional practice at that time, but so was the science of statistics and the ways in which physical characteristics vary when measured was not then generally appreciated.

It is evident that some of the techniques that are still used were developed using a limited supply of dry bone material before being applied to the wider, more variable, patient population. A brief mental review of the classical procedures used commonly in skull radiography will reveal that most are guidance fixates based upon simple unvarying fractions of a circle. Could Nature really have been so felicitous as to have situated structures so regularly? Evidently not, for the temporal bone varies in shape [11] and in the angle which the petrous part subtends with the median sagittal plane [8]. Furthermore, Downs [12] has noted that in upright, relaxed subjects, the Frankfurt plane is almost parallel with the ground which is probably due to the way in which the semicircular canals within the petrous bone are orientated in space. Some physical anthropologists [13-15] are now using the plane of the horizontal semicircular canals instead of the Frankfurt plane as the reference plane for measurements because it is seen as being more fundamental to the head than a line that simply joins bony points, each of which has different embryological origins and growth histories. Allowing upright subjects to take up the relaxed head position for themselves may, therefore, be a more accurate way of aligning the semicircular canals than making imaginary skull lines conform to standard orientations.

### **Cross-sectional versus longitudinal studies**

Many clinically-based studies require the patient to be followed over a period of time in order to observe the effects of a particular treatment. Sometimes there is a tendency to think that all research involving people ought to have some element of repetition. Studies that follow subjects over a period of time are called longitudinal studies and are typical of studies into growth and ageing. Many studies look at individuals only once, however, and are called cross-sectional studies because, in effect, they take a slice through the population at a single point in time and concern themselves only with those that fall within that slice. A typical example of a cross-sectional study would be one that sought to determine the current average height or some other such parameter of the population.

### **Studying the skeleton - a role for radiography**

In 1957, a symposium of the Society for the Study of Human Biology (SSHB) noted the lack of osteological material available for teaching and research [16]. This state of affairs still persists, as can be evinced from the market in plastic skeletons which

would not have otherwise arisen in recent years. While some plastic skeletons are of excellent quality, they are never like the real thing. More importantly, all plastic skeletons of a particular type are identical. There is no sense of individual variability in shape or size.

To obtain genuine bones is no easy matter and cannot simply be taken from those who donate their bodies for anatomical study. Frequently, they are sawn through to gain access to other structures and those that are not damaged beyond usefulness require much laborious preparation. Furthermore, very little anatomical material may be kept without prior consent and so the remains of the deceased are collected and afforded a proper funeral.

Many osteologists have made use of bones from crypts etc. where 'defleshing' has been a slow, natural and thorough process. However, in using this approach, it is frequently impossible to obtain background information about the age, sex or other features of the lives of the people from whom the bones come. In such work, radiography has been used as a research tool from the outset. Stewart Culin at the University of Pennsylvania seems to have been the first to use X-rays to study ancient human remains - those of a Peruvian mummy - as early as 1897 [17], although a mummified bird from an Egyptian tomb was X-rayed by Charles Thurstan Holland on 22 October, 1896 [18]. More recently, archaeological work has continued to appear in the radiographic press (for example: Lorimer [19] and Jones and Howell [20] and Capel [21]). In the study of normal human skeletal variation, Brothwell, Molleson and Metreweli [17] pointed out, at another SSHB symposium, that radiography had not, however, been used to its full potential. This remains the case today. If normal skeletal variation is to be studied thoroughly, it must be done radiographically using sizable samples about which details of age, sex etc. are known.

While it is acknowledged that there are some limitations to the complete and geometrically accurate imaging of some adult long bones, for example, there can be little doubt that the greatest centres of osteological information are the filing rooms of hospital X-ray departments. The number of bone radiographs produced in this country each year must exceed its collection of 'dry bones' many times over.

Academic departments involved in osteological research often have small X-ray machines operated by technicians who have received minimal training and for whom this is a secondary aspect of their job. One of the shortcomings in much of the scientific use of radiography has been the lack of a standardized radiographic technique between institutions.

Radiographic training, however, places much emphasis on the accurate and uniform demonstration of parts. Thus, the radiographs produced by professional radiographers in the clinical setting are inherently superior to those produced in many prestigious academic institutions. Importantly, because of the standardization of the demonstration of parts, it is possible to make direct comparisons between clinical radiographs - even when they have been produced in different parts of the world.

In osteological research, radiography is frequently called upon to produce images from which measurements are taken for use in metrical and morphological studies. X-ray filing rooms, or 'centres of osteological information', as they have been called, therefore, constitute a vast potential database for osteological research waiting to be treated in the same way. Some years ago, the National Hospital for Nervous Diseases set something of a precedent, of which few are now aware, when it donated 10 000 documented skull radiographs of patients, covering a range of ages, to the Natural History division of the British Museum [16]. It is not suggested one should adopt a wholesale loss of revenue from silver recovery but rather the use of selected radiographs during an interim phase prior to disposal.

The approach has also been used by the author in a study of hand morphometry [22]. This was carried out under the auspices of the X-ray department of Ysbyty Gwynedd. Here, the collected data were derived from clinically-produced hand radiographs corresponding with a geographically distinct modern population. From this, it has been possible to build up a database of measurements which has proved useful to a range of workers in comparing bone sizes and other hand features with those in groups elsewhere in the world and from other historical periods [23].

### **Applied human biologists**

Clarke [24] discussed a role for doctors as 'applied human biologists', understanding health and disease in a broader biological perspective. This ethos has developed over the years with contributions from inside and outside the scientific community. There is still much that remains to be investigated and there are ways of understanding the human situation that have yet to be fully recognised. There can be no reason why radiographers cannot be fully involved in this process. Contributing to the study of the skeleton is only one way in which this may be done. The general principle applies to other tissues and to the newer imaging modalities, where visualization and measurement of other structures is undertaken. Radiographic images may also be used to provide information of a more epidemiological

nature. For example, although it is commonly held that limb injuries are more frequent during the slippery winter months, this is far from certain. Questions about the most common types of injury sustained during falls, which sex or age group is most commonly affected and whether the pattern is the same all over the country, in both urban and rural areas, remain to be posed, let alone answered.

## **Conclusion**

By virtue of the frequency with which they are encountered, there are questions which radiographers are uniquely situated and qualified to consider. By utilizing some of the ways of thinking typified in Medawar's experimental types, it may be possible to redefine these questions in a way that fuels radiographically based research projects. The pragmatic nature of working with patients, leads one to the realization that such questions, transformed into 'hunches' (or hypotheses) can sometimes be addressed without the need for direct experimentation with its resultant ethical problems or the expenditure of large sums of money. Furthermore, there are reputable academic departments which, in the pursuit of research, are spending meagre resources on producing a limited number of radiographs (sometimes of questionable quality). There are numerous X-ray departments without a research background producing images under quality-controlled conditions, within a profession whose education and training arm is seeking new ways of conducting its research. From the examples given here, it might be argued that those radiographers who wish to conduct osteological research are in a very fortunate position. However, the wealth of potential anatomical data that can be generated via other imaging modalities should not be overlooked. There is a vast amount of material available. All that remains to be done is to think of a use for it.

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