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Identification of children (or adults) by mass miniature radiography of the cranium.

A preliminary report.

By

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The problem of providing for the identification of children in wartime has long been under discussion, and has so far evaded satisfactory solution.

This preliminary report presents a fresh approach to the subject in the application of mass miniature radiography as a complement to other methods of identification. The method is suitable in the case of both children and adults, living and dead.

The identification of adults in wartime is generally concerned with dead persons. The magnitude of the work of identification during and after a war is illustrated by the fact that the United States War Department required that 274,000 American soldiers fallen in Europe during the Second World War should be located in their graves, identified and returned to their relations (WELTY & GLASGOW).

The identification of living adults may also often present difficulty; for example, in amnesia and other mental disorders, but the adults are for the most part able to account for their personal data.

Children on the other hand are unable to provide satisfactory information in this respect. Even if the child has learned to say its name and address, it might forget them completely if removed

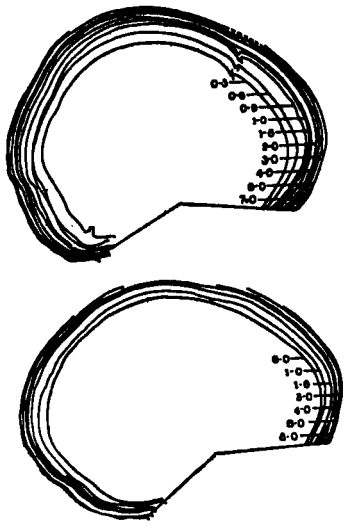

Fig. 1. Growth of the cranium from 3 months to 8 years; 2 children with different skull types. The permanence of the form is striking (BRODIE).

from its normal environment for any length of time. The youngest will not, of course, be able to provide any information at all.

The last war has revealed the very great difficulty of identifying and returning to their relatives or acquaintances children who have found their way far from their home districts. There are at present according to a newspaper report about 35,000 children in Europe who are unknown; a large percentage of these will probably never be identified, as there is nothing to work from.

There may be no photographs for comparison or else the appearance of the child has changed so much that the photographs are of no help. There is no finger print record available. The teeth that might often provide assistance are a less valuable guide in the case of children than of adults. For example, the deciduous dentition may have been partly or completely replaced by the permanent teeth.

It is thus a question of finding some more permanent characteristic that can be recorded, and preferably classified. Finger prints have been suggested and are perhaps the simplest method in the case of living persons or those who have recently died and have well-preserved finger tips; but this is no answer to the problem when it is required to identify persons, alive or dead, whose finger tips are destroyed. There are, moreover, psychological objections to this method.

The method for identifying children that has been worked out by the authors makes use of profile radiographs taken with the photo-fluorographic apparatus (70 mm film). This is based partly on recent cephalometric methods of examination in orthodontics and results of investigations of the growth of the cranium during the years of childhood and partly on a special survey picture of the teeth.

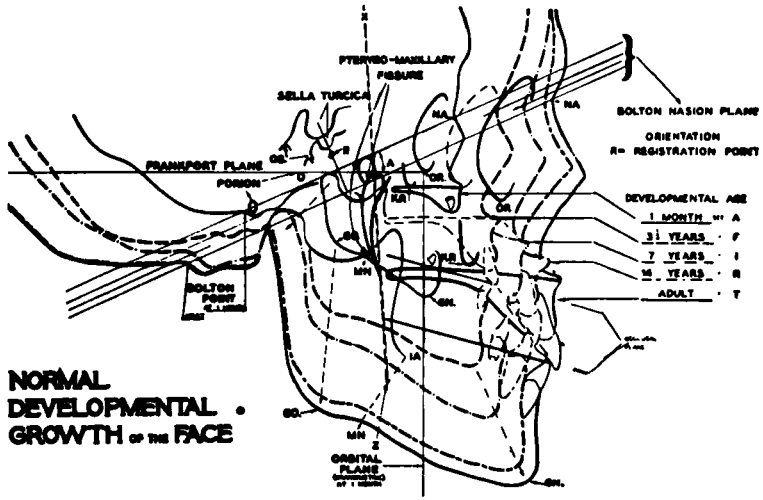

Fig. 2. Growth of the facial skeleton from the first month to adult age; the development is along straight lines. The tracings from the different ages have been superimposed with the R points coincident and the Bolton planes parallel (BROADBENT).

Scientific basis.

At the age of one year the length of the brain pan has already reached 82 per cent of the average adult length (DAVENPORT).

The shape of the cranium is fairly constant after the first year (BRODIE). (Fig. 1.)

BROADBENT maintains that the facial skeleton, too, develops for the most part along definite lines. (Fig. 2.)

There is still need for caution in judging the growth of the facial skeleton, however; ARNE BJÖRK claims to have found a number of substantial changes in some facial angles during growth.

Examples of some of the facial angles that have been the object of cephalometric investigations are given in Fig. 3. (BJÖRK.)

Technique.

In the preliminary experiments X-ray profiles were taken of 100 children and adults using the camera unit of a modern photo-fluorographic apparatus for lung examination.[1] Figs. 4 (a) & 4 (b).

[1] The photo-fluorographic unit has been kindly placed at our disposal by the makers, AB Georg Schönander, Stockholm.

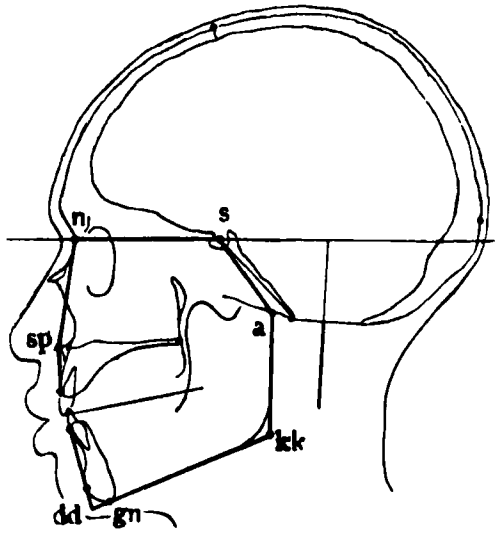

Fig. 3. Diagram for measuring variation in the facial skeleton and skull base from lateral radiographs (BJÖRK).

Fig. 4 (a). Photo-fluorographic unit FFS-4 by Schönander.

The cephalostat (by THÖRNE) has been used to obtain periodic identical radiographs. Care was taken that the direction of the central ray was the same for all exposures.

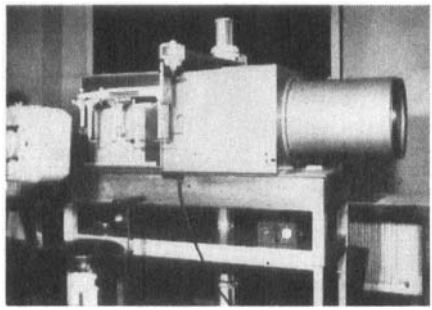

Fig. 4 (b). The camera unit in the apparatus illustrated in Fig. 4 a is placed horizontally and combined with a Tuto-Ventil Heliodor-Röntgen.

The focus-screen distance was 1 metre and, in a few test cases, 1.5 m. The tests are continuing. From the theoretical aspect it is desirable that the distance should be great to eliminate as far as possible the effect of enlargement. The enlargement is — at least in analyses for orthodontic purposes — disturbing from the point of view of mensuration, especially in the case of growing skulls. It is possible, however, that for measurements for identification purposes short distance radiographs would be sufficient. This would be an advantage as the long distances in miniature radiography call for a very powerful apparatus.

The quality of the radiographs has shown a certain irregularity but in many cases has been remarkably good. The irregularity is due mainly to the difficulty in choosing the correct exposure time. A more even quality is obtained if a photo-timer is used, this automatically determining the exposure in each case.

The radiographs might still be improved appreciably if a camera were constructed specially for the purpose. Such a camera could then give radiographs covering the whole film, thereby doubling the area of the image.

Fig. 5 is a survey picture of the teeth, prepared with a known oblique projection and the mouth open (23 mm in the incisor region). Such a radiograph provides a view of all the lateral teeth. The incisors are, however, projected on one another, but this does not preclude important verifications such as the pres-

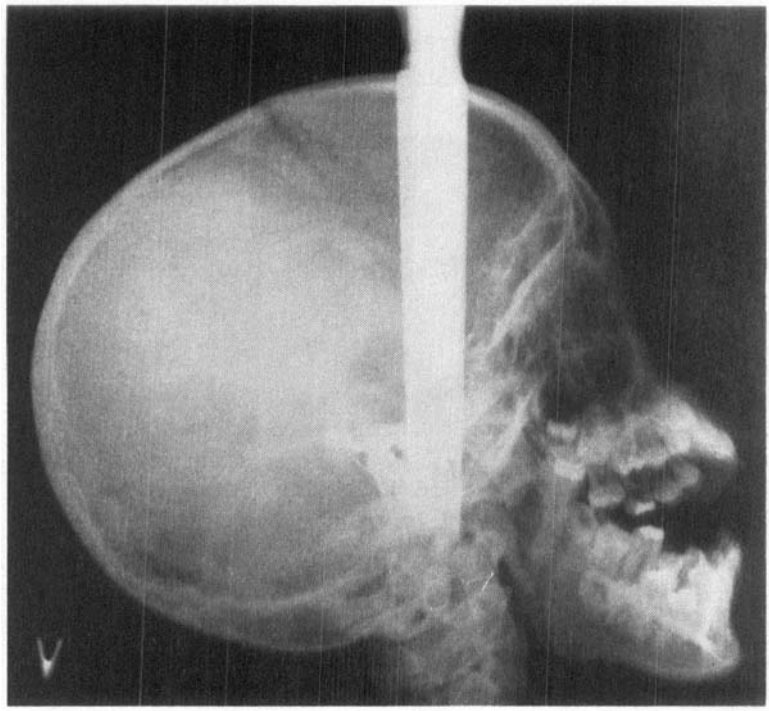

Fig. 5. Survey radiograph of the dentition obtained by a known oblique projection with the head fixed in the cephalostat and the mouth open 23 mm measured in the incisor region.

ence of root fillings, metal pins and metal fillings. The lateral view of the dentition might be complemented with a frontal view of the anteriors. Occlusal aspects of the upper and lower jaws might be taken by the usual X-ray technique, if necessary, to provide further characteristics.

The radiograph can be studied in a magnifying viewer. For the measurement of the cranial angles, etc., the projector must be used. Radiographs are projected and enlarged on paper or on matt glass plates from which a tracing may be prepared.

Classification.

For the classification of the material it is intended that characteristics should be obtained from the survey picture of the dentition and from a pure skull profile. (Fig. 6.) For the identifica-

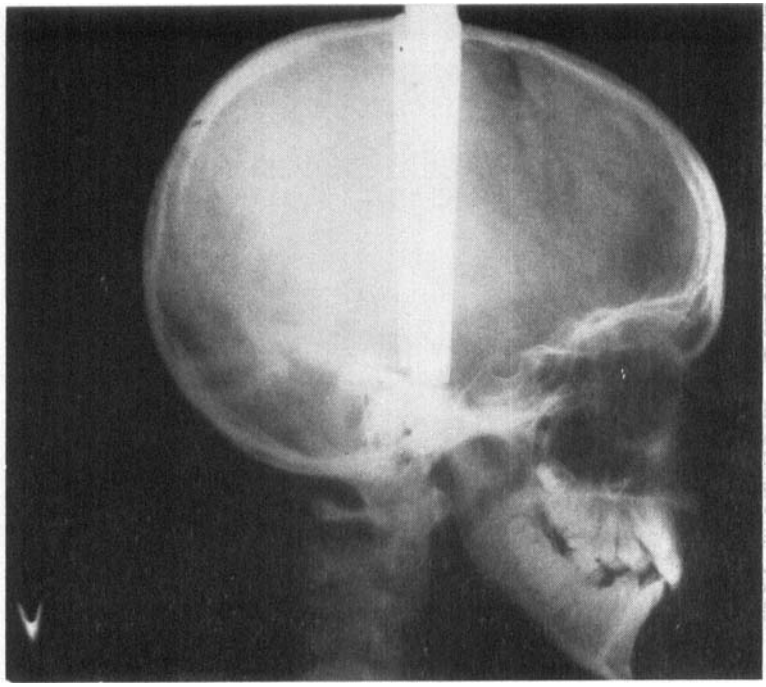

Fig. 6. Profile radiograph with central ray passing through both auditory canals; Frankfort plane horizontal.

tion of children the pure skull profiles would be of the foremost importance, while for adults, in addition to distinctive features of the cranium, the dentition radiograph (Fig. 5) provides a rich source of characteristics. It is tentatively suggested that use might be made of gaps, fillings, crown and bridge restorations, metal pins, abutments, root fillings etc., but these will not be dealt with here.

In the systematic use of the pure skull profiles (with the central ray through both auditory canals) (Fig. 6) the individual variations in the magnitude of the facial angles (Fig. 3) can be expected to be of value for classification purposes. First choice should be given to angles that investigators (BJÖRK etc.) have shown to have large ranges of variation; for example, the skull base angle (n—s—a on Fig. 3), the profile angle s—n—sp (or similarly), the chin angle (at dd), and possibly the jaw angle (at kk).

Another dimension of value can be the height/length index of

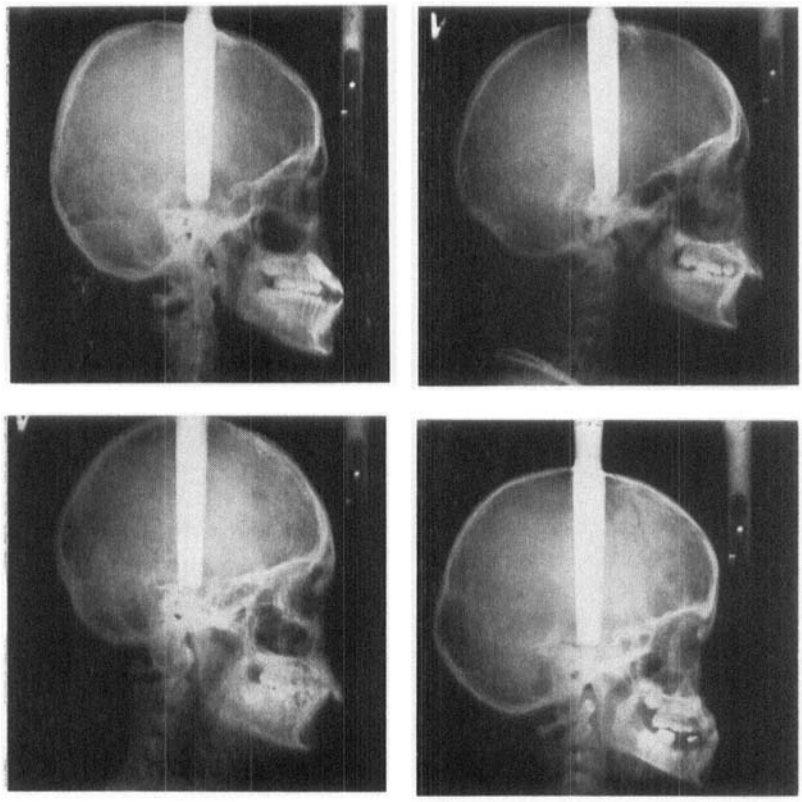

Fig. 7. Some different cranial forms.

the cranium. Other characteristics of the cranial radiograph may prove of interest.

How many classification categories might be obtained by suitable grouping of angles and index numbers cannot at present be decided.

The suggested characteristics require thorough revision. A point to be emphasized, however, is that the construction of such a system of classification does seem feasible. It would probably be best if it could be developed during the course of work on a large number of profile radiographs. Before any large investigation can be planned, however, special apparatus for the type of cranial radiography in question must be constructed.

The work of creating a system of classification will in all probability require a considerable time. There is no reason,

however, why this should prevent the compilation of a large register, for example, for the children of bigger towns. This might be of great value even if it is not fully classified. In many cases there is of course some clue by which the number of cards to be examined may be limited.

Results of the investigation.

In the tests each of the 100 persons was radiographed twice at an interval of some months. On each occasion two radiographs were taken of each person. One of them was an orthophoric profile with the central ray passing through both auditory canals. On the other radiograph a survey of the whole dentition was obtained by a known oblique projection.

In attempts to pair up the radiographs of the two occasions it was found possible to effect recognition in all 100 cases without difficulty.

The results do not of course indicate the serviceability of the method for growing children with long intervals between exposures — of some years, for instance. For this a long term investigation of children would be required. It appears, however, that the method is applicable for children at short intervals and for adults at arbitrary intervals.

The number of subjects is too small to justify definite conclusions with regard to the applicability of the method with a very large number of persons — hundreds of thousands, for instance; but an accuracy of 100 per cent is a promising indication.

Practical application.

How is it intended that the system should be used?

The central radiograph register of children of 1—6 years and of adults in certain dangerous jobs — flying personnel, seamen, firemen and conscripts — is compiled for large towns and other suitable population units. The register is classified and archived.

If a person is to be identified the head is radiographed in profile with a cephalostat according to some agreed method, but not necessarily with the miniature radiograph apparatus. Copies of the radiographs are sent to the appropriate central registry, where the characteristics are transformed into figures. A small number of cards can then be selected from a card index, the

data on which could apply to the unknown person. The films for these cards are then examined. With the aid of the details in the radiographs the pair most closely corresponding to the unknown person is found.

The idea of using cranium radiographs for identification purposes by the above method has been applied in the planning of an investigation of the growth of child skulls. Attention has been directed to the practical and economic advantages of miniature film which assume considerable importance in large scale examinations for the identification purposes.

Summary.

The method is based mainly on earlier investigations by BRODIE and BROADBENT, showing the constancy of the growth pattern of the human head during development. (Figs. 1 and 2.)

100 persons (children and adults) were X-rayed. Two exposures were made of each person using a cephalostat and a photo-fluorographic apparatus. The focus to film distance was 1 meter.

One of the pictures thus obtained gives a general view of the teeth. It has been produced by an oblique-angle projection technique with a jaw separation in the incisor region equal to 23 mm. The other picture is an orthophoric profile radiograph, the central X-ray passing through the ear-holes.

The pictures can be studied in a magnifying viewer. For measuring cranial angles etc. a projector is used.

Results.

About one month after the first exposures were made, the same group of 100 persons was X-rayed a second time. Then efforts were made to match the pictures from the second occasion with the original set of radiographs. It was possible to perform such an identification in all cases without difficulty.

The authors consider it quite feasible to work out a classification system, using fillings, crown- and bridge-work, metal pins, root-fillings, gaps etc., observed in the picture of the teeth. In the orthophoric profile radiograph the individual variations of cranial and facial angles, the height/length index of the skull and other characteristics will be of assistance.

Zusammenfassung.

Die Methode gründet sich hauptsächlich auf frühere Untersuchungen von BRODIE und BROADBENT, die die Beständigkeit der Zuwachsform des menschlichen Kopfes während der Entwicklung zeigen. (Abb. 1 und 2.)

100 Personen (Kinder und Erwachsene) wurden röntgenphotographiert. Zwei Aufnahmen von jeder Person wurden gemacht, wobei ein Kephalostat und ein Schirmbildapparat benutzt wurden. Der Abstand zwischen Brennfleck und Film war 1 Meter.

Das eine Bild gibt eine allgemeine Uebersicht von den Zähnen. Es wurde durch eine schrägwinklige Projektionstechnik mit einer Mundöffnung von 23 mm in Frontzahngebiet hergestellt. Das andere Bild ist ein reines Profilbild. Der Zentralstrahl passiert durch die Ohröffnungen.

Die Bilder können in einem vergrössernden Betrachtungsapparat studiert werden. Beim Messen von Schädelwinkeln u. dgl. wird ein Projektor verwendet.

Resultate.

Etwa 1 Monat nach den ersten Aufnahmen wurde dieselbe Gruppe von 100 Personen ein zweites Mal geröntgt. Danach wurde versucht, die Bilder von der zweiten Gelegenheit mit den ursprünglichen zusammenzupassen. Es war möglich in allen Fällen eine derartige Identifizierung ohne Schwierigkeit durchzuführen.

Die Verfasser meinen, es wäre durchaus möglich ein Klassifikationssystem auszuarbeiten, wobei Füllungen, Kronen- und Brückenarbeiten, Metallstifte, Wurzelfüllungen usw., die im Bilde der Zähne sichtbar sind, ausgenützt werden sollten. In dem reinen Profilbild können die individuellen Variationen von Schädel- und Gesichtswinkeln, der Höhe/Länge-Index des Schädels u. dgl. verwendet werden.

Résumé.

La méthode se base principalement sur des investigations antérieures par BRODIE et BROADBENT, montrant la façon constante dont croît la tête d'homme pendant son dévéloppement (fig. 1 et 2).

100 sujets (enfants et adultes) ont été radiographiés. Deux expositions ont été faites de chaque sujet en employant une céphalostate et un équipment de radiophoto. La distance entre le foyer et le film était de 1 m.

L'une des images ainsi obtenues donne une vue générale des dents. Elle a été produite par une technique de projection d'angle oblique, la séparation des mâchoires de la région des incisives étant équivalente à 23 mm. L'autre image est une radiophoto de profil orthophorique, le rayon central passant par les conduits auditifs.

Les images peuvent être étudiées par un viseur agrandissant. Pour le mesurage d'angles craniens etc. un projecteur est employé.

Résultats.

Environ 1. mois après que la première exposition fut faite, le même groupe de 100 sujets fut radiophotographié encore une fois. Après cela des efforts ont été faits d'accoupler les clichés de la deuxiéme occasion et l'assortiment primitif de radiophotos. Il est possible de faire une identification dans tous les cas sans difficulté.

Les auteurs le considèrent tout à fait possible de dresser un système de classification en employant des plombs, des constructions de couronnes et de dentiers, des pointes de métal, des plombs de racines etc., observés dans les radiophotos. Les variations individuelles d'angles craniens et faciaux, l'index de hauteur/longueur du crâne ainsi que d'autres détails caractéristiques seront aussi très utiles.

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