R (on the application of ZM and SK) v The London Borough of Croydon (Dental age assessment) [2016] UKUT 00559 (IAC)

Upper Tribunal (Immigration and Asylum Chamber)

Heard at Field House
on 7 and 17 October 2016

IN THE MATTER OF AN APPLICATION FOR JUDICIAL REVIEW

Before

MR C M G OCKELTON, VICE PRESIDENT

Between

THE QUEEN ON THE APPLICATION OF ZM

<u>Applicant</u>

and

LONDON BOROUGH OF CROYDON

<u>Respondent</u>

And

THE QUEEN ON THE APPLICATION OF SK

<u>Applicant</u>

and

THE LONDON BOROUGH OF CROYDON

<u>Respondent</u>

Representation:

Mr I Wise QC and Mr C McCarthy instructed by Bhatia Best Solicitors, appeared on behalf of both Applicants.

Mr J Swirsky, instructed by London Borough of Croydon Legal Department, appeared on behalf of the Respondent.

1. *Considerable circumspection must always be deployed in responding to a claim that statistical evidence tends to prove a fact about an individual. Statistics may be more useful to decision-makers at the far ends of the scale (where they may be able to show the plausibility or implausibility of a proposition) than in the middle of the scale where they purport to show the likelihood of the correctness of a plausible proposition.*

2. *When considering statistical evidence it is always necessary to determine whether the population constituting the database from which the statistics are drawn is sufficiently identical to the population from which the individual is drawn.*

3. *The fact that all teeth are mature in the sense that all have reached Demirjian stage H is a sign of chronological maturity but is not a reliable indicator of whether an individual is more or less than 18 years old. The use of the Demirjian stages below stage H does appear to be more reliable in the prediction of age, particularly in the lower teens.*

4. *None of the three mandibular maturity markers so far identified appears yet to have attained such acceptance in the scientific community that it can be accepted as a reliable pointer to chronological age in the late teens in males.*

5. *Dental wear is not a guide to chronological age in the absence of data for a population with similar diet and masticatory habits to those of the person under examination.*

6. *The decision of the Court of Appeal in <u>London Borough of Croydon v Y</u> should not be read as prohibiting a person from refusing to undergo a dental examination. However, (i) the risk inherent in the exposure to x-rays during the taking of the dental panoramic tomograph is not likely to be a reasonable ground for refusing to allow the tomograph to be made, given the advantages stemming from ascertainment of an individual's true age, and (ii) despite the reservations expressed herein, analysis of a person's dental maturity may well have something to add to the process of assessing chronological age.*

7. *It therefore follows that generally speaking the taking of a dental tomograph should be ordered if a party seeks it, and (because of the process of dental maturity) the earlier the tomograph is taken, the more likely it is to be of assistance.*

DECISION ON APPLICATIONS

1. This judgment contains general guidance on the use of evidence of dental development in the assessment of age.

2. In each of these judicial review applications, the applicant challenges the assessment of his age by the respondent London Borough of Croydon. ZM arrived in the United Kingdom in 2015. He says he is from Afghanistan and was born on 10 May 2001. He was assessed by social workers working for London Borough of Croydon. They decided on 23 November 2015 that he was over 18 years old. The present proceedings were issued on 4 December 2015. Permission was granted by Picken J at an oral hearing on 28 January 2015 and the claim was transferred to this Tribunal.

3. SK came to the United Kingdom in 2015. He claims to be from Afghanistan and to have been 15 years old at the time of his journey to the United Kingdom. An age assessment was undertaken by social workers employed by Croydon; their decision on 16 September 2015 was that he was over 18. The present claim was issued on 1 October 2015. Permission was granted by Sir Stephen Silber on 28 January 2016 and the matter was transferred to this Tribunal.

4. In each case application notices have been filed by the respondent. For present purposes they are to similar effect. They may be summarised as seeking an order from the Tribunal that the respondent be permitted to rely on expert evidence from Professor Graham Roberts (whose relevant expertise is in dental development). It is common ground that in each case it will be necessary for a dental x-ray to be taken as part of Professor Roberts' assessment. The respondents further seek in each case an order that if the applicant does not agree to be assessed by Professor Roberts (including by the taking of the x-ray) his claim be struck out. In the application relating to ZM further disclosure is also sought, and the respondent seeks an order that the claim be stayed as an alternative to being struck out if the applicant does not comply with either element of the substantive directions sought.

5. These applications were listed for hearing, with copious expert evidence, including in particular a full report from Professor Roberts, and supporting documentation and articles, on 10 and 17 October 2016. I heard oral evidence from Professor Roberts, called by Croydon; Professor Cole, one of the applicants' witnesses, assisted me in the analysis of Professor Roberts' evidence, but did not in the end give substantive evidence. At the conclusion of Professor Roberts' evidence I gave my provisional views on it and on the application. It was agreed that no further oral evidence was necessary and the matter proceeded to submissions. At the end of the submissions, on 17 October, I decided that the applicants should undergo the x-rays and that the parties would be at liberty to rely on such expert interpretation of the x-rays as became available to them: I indicated that the full reasons for those directions would follow in writing.

THE LEGAL BACKGROUND AND THE BACKGROUND TO CROYDON'S APPLICATIONS

6. The starting point in these cases, as in most age assessment cases, is that the applicant claims as a child to be entitled to services under or derived from the Children Act 1989. The local authority declines to provide the services, on the ground that the applicant is not in truth a child. The issue of the applicant's age is thus the matter in dispute. In R (A) v Croydon LBC [2009] UKSC 8 the Supreme Court decided that to the question whether an individual is or is not a child "there is a right or wrong answer" (Lady Hale at [27]) and that it was for the Court to determine it. Subsequent decisions have made it clear that the determination of an applicant's age is to be made on all the evidence available and, where relevant, an assessment of its credibility. Although the formal dispute between the parties is as to the accuracy or otherwise of an assessment already made, the Court is not concerned merely with choosing between the age claimed by the applicant and the age assessed by the respondent, but, in the exercise of its supervisory jurisdiction, it

is to decide on the balance of probabilities whether the applicant was or was not a child at the relevant time (R (CJ) v Cardiff City Council [2011] EWCA Civ 1590).

7. The Supreme Court's decision in A is based firmly on the wording of the Children Act 1989. Numerous challenges to age assessments on the basis of their actual accuracy have subsequently been brought. Most have been transferred to, and are decided by, this Tribunal. Although as a result of the decision in A, it is clearly the Court's or Tribunal's task to determine an individual's age in proceedings of this type, there is no reason at all to suppose that a judge, looking in detail at the evidence made available in a single case, is any better at determining a person's age than competent social workers constantly dealing with young people, some of known and some of unknown age. Indeed, the reverse is probably true. And there is, of course, no way of telling whether or not the judicial decision has been accurate in any of the cases that have been the subject of litigation, nor whether it has been more accurate than the original decision under challenge. It is within everybody's experience that some individuals, particularly individuals in their teens, may seem much more mature (or less mature) than their known age would suggest. As a result, everybody knows that there is no sure way of assigning a chronological age to an individual, particularly a teenager or late teenager, on the basis of physical, mental or social characteristics. Age assessment judicial reviews are lengthy and expensive, almost always wholly at public expense. The only certainly correct propositions that can be made about them are that they enable those professionals involved in them to derive an income from the public purse, and that the system satisfies the demands of the law, however irrational it may be to regard its substantive results as either correct or an improvement on any other age-assessment system.

8. In this context it is not surprising that there has been a search for a testing process which might enable an accurate, objective assessment of the age of a young person whose age is unknown. In recent years, one of the targets of interest and research has been related to dental development. Some respectable opinions suggest that, in certain circumstances, an examination of an individual's dental development can give a very clear and accurate guide to that individual's age.

9. Because of the geographical situation of Home Office premises, the London Borough of Croydon is a frequent respondent in age assessment claims. It appears to have adopted the view that age assessments based upon dental development are sufficiently reliable to be of great assistance, although Mr Swirsky emphasised to me that Croydon does not seek a dental age assessment in every case. In London Borough of Croydon v Y [2016] EWCA Civ 398 Croydon had applied to this Tribunal for an order that Y's challenge to his age assessment should be struck out (or stayed) unless he consented to and cooperated fully with (i) a dental examination (including a dental x-ray) by Professor Roberts, (ii) a psychiatric examination and (iii) a further age assessment by two Croydon social workers. The applicant made it clear that he would not cooperate with the dental examination. The Tribunal refused the order sought. On appeal, the Court of Appeal decided that each of the reasons given by the Tribunal for refusing the order was not sound. The order itself could therefore not stand. The Court substituted an order granting

the application. In the words of the Master of the Rolls, who gave the lead judgment, at [22]:

> "Having rejected the three reasons relied on by the judge, I am satisfied that the judge should have made the order sought by Croydon. It was reasonably necessary to enable it to defend the challenge to its age assessment. Y's refusal to give his consent was unreasonable."

10. It is, I think, fair to say that the only consideration of reasonableness was in relation to the timetable (on which the Court found that the judges' assumed concerns were misplaced), not on the substantive question of the efficacy of evidence from Professor Roberts or any dangers arising from the dental x-ray. At [23], the Master of the Rolls said this:

> "By way of a postscript, I wish to add two points. First, although Y's expert witnesses have diagnosed him as suffering from complex PTSD, it is not suggested on his behalf that any of the three requested assessments would cause him psychological harm. Secondly, it is said that the method of assessing age using mean data taken from dental x-rays is controversial and unreliable. But it is impossible for the court to reach a conclusion on whether this is correct or not. In my view, it cannot be a reason for refusing the order. No doubt, the reliability of the assessment based on dental x-rays will be investigated at the hearing."

11. So far as dental examination is concerned, the orders sought in the present cases are similar to that in Croydon v Y. I do not, however, read the decision of the Court of Appeal in that case as prohibiting for all time the refusal of such an application. As the closing paragraphs of the Master of the Rolls' judgment made clear, a crucial question is whether in an individual case the conduct of the person opposing the application is reasonable. Further the decision of the Court of Appeal was made in the context of no decision being taken on the extent to which evidence derived from dental x-rays could assist age assessment in general or the assessment before the Tribunal in that particular case.

12. It is not clear from the decision whether Y had indicated any reason for his decision to refuse to cooperate. In the present cases a reason was formulated: the perceptible danger of exposing an individual to x-rays. That is a matter that therefore fell, or appeared to fall, for consideration as part of the determination of the respondent's applications.

THE ISSUES

13. In considering whether the orders ought to be made in the present cases, and what, if any, guidance can be given on the use, in age assessment judicial reviews, of a data obtained from dental x-rays, the following considerations therefore arise. First, what can be said about dental development as seen by x-radiograph or otherwise in relation to the chronological age of an individual? What data are available, and what observations can reliably be made about those data? Secondly, to what extent can the answers to the first question be used to reach a conclusion about the age of an individual whose age is unknown? In particular, to what extent can the data be used to determine whether an individual of unknown age is more

or less than 18 years old? The answer to these questions depends not only on the availability of data, but on the propriety of reasoning from the statistical analysis of a database to the determination of characteristics of an individual not within that database. Thirdly, given that a Tribunal is unlikely to be able to assess the raw data itself, is the interpretation provided by an expert (and Professor Roberts in particular) sufficiently reliable to assist the Tribunal in determining an individual's age? Fourthly, what, if any, are the dangers of undergoing a dental x-ray?

THE DEVELOPMENT AND APPEARANCE OF TEETH

14. This section is intended to be an uncontroversial summary of the relevant parts of the material before me. More controversial issues, including the interpretation and use of the materials summarised in this section, are included in subsequent sections.

15. Human teeth emerge individually and develop gradually. It is possible to observe their emergence and other morphological features during a clinical examination, but a detailed examination of dental development requires an x-ray.   The standard method used is a dental panoramic tomograph, which, by recording data from around the outside the mouth, provides an image showing all the teeth in more or less straight lines with their roots arrayed and so readily examinable.   The tomograph enables individual teeth to be assigned to specific stages of development.

16. Several systems of classification of stages have been proposed. That used by Professor Roberts and, as appears from the literature, very many others, is derived from a paper by Demirjian and others [1], although the *assessment* process outlined in that paper is not adopted by Professor Roberts or perhaps by anybody else. Eight stages are identified, lettered A-H: I do not need to set these out, save to say that the difference between G and H is that in G the ends of the root canals are still partly open, whereas in H they are closed (specifically, in molars, the distal root is closed). The description of stage H includes also the following wording: "The periodontal membrane has a uniform width around the root and apex". The 8-stage scheme is said to be amenable to accurate application, in the sense that analysts can readily be trained to assign individual teeth accurately to the correct stage.

17. Individual teeth attain different stages at different speeds, but typically teeth nearer the front of the mouth are at a later stage of development than those further back. The third molars [2] are the last to emerge and normally the last to achieve full maturity at stage H.

18. It is apparent from the foregoing that a tooth which has not reached stage H is somewhere on its road to doing so, but a tooth which has reached stage H is fully mature; and if the entire dentition has reached stage H no further development that

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[1] Demirjian *et al*, "A New System of Dental Age Assessments", Journal of Human Biology, May 1973, pp. 211-227

[2] I have used verbal descriptions throughout this judgment. The permanent lower left third molar is LL8 (lower left, 8th tooth from the front) according to the British Dental Journal nomenclature; a letter A-H may be added to indicate maturity and m or f to indicate sex. The same tooth according to the Fédération Dentaire Internationale (called Fedaire Dentaire Internationale by Professor Roberts and in DARLInG) notation is 38 (third sector, eighth tooth and pronounced 'three eight').

can be described by the 8-stage process can take place. Until then, it is possible to provide a description indicating which (if any) of the teeth have reached stage H and, in addition, listing those teeth which have reached other and if so what stages. A number of databases have been assembled, which have been available to individual authors. There are thus data relating to a number of different groups.

19. The reference data set used by Professor Roberts is that assembled by the Dental Age Research London Information Group (DARLInG), consisting of a large number of white Caucasians of known age. Because a stage earlier than H is, during the process of dental maturation, both achieved *and lost* (by attainment of the next stage), it is possible, by comparison with the database, to generate information about the ages between which the stage in question typically occurs in the tooth in question. The more immature teeth there are in the mouth, the more information can be generated in this way and, it is said, the more accurate is the prediction of the age of an individual of unknown age. The method used is a simple average: the average ages of those in the reference data set displaying the observed stage of each individual tooth are themselves averaged together to provide a predicted age for the individual. This is accompanied by an estimate of error calculated as the inter-quartile width, similarly averaged. The results, tested by prediction in this way of the age of individuals whose chronological age is in fact known, but not to the examiner, are impressive at the beginning of the teenage years. Not surprisingly, it appears that this method loses accuracy as the number of immature teeth available to be used in the calculation decreases as more teeth attain stage H. Nevertheless, the simple average method, as described above, is used by some examiners for the purposes of dental age assessment in all cases where there is at least one tooth that has not reached stage H.

20. This method is not applicable when all the teeth have reached stage H: the dentition is mature and will remain mature whether the individual is 17, 37 or 87. Further, because of the way in which the data is assembled, that is to say, typically, by the examination of individuals at unplanned stages of their dental development, there is no way of knowing how long an individual showing mature dentition has been in that state. The tooth that most recently achieved stage H may have done so six months ago or two years ago or (in the case of an older individual) twenty years ago. What can be done is to record the ages of those whose tomograph shows completely mature dentition. In each case this is not, and can not be, a record of the age at which the individual achieved dental maturity: it is, instead, a record of the lowest possible age at which dental maturity was reached. In a large database, however, these data can usefully be compared with the ages of those who were at the last stage before completed dental maturity, that is to say, with one tooth only at stage G. In the result, data for the attainment of stage H in all teeth, or in the lower left third molar, which is regarded as a diagnostic sample, have been collected for a number of populations.

21. There is considerable difficulty in determining whether those data can properly be converted into probabilistic estimates of the chronological age of a person of unknown age who is dentally mature. Without any detailed calculation, the sparsity of records of young teenagers with teeth all at stage H might well suggest that a claimed age of 13 is highly unlikely. Much more difficult is the assessment of

the probability of the individual in question being more or less than 18 years old. The difficulty arises not merely because of the inherent dangers of calculating the facts from probabilities, to which I advert below, but because the data collected do not have a Normal Distribution. That is the consequence both of the method of their collection and of the fact that an individual with fully matured dentition may be very substantially older than the age at which he or she achieved mature dentition. One method of deriving an estimate of probability from data of this sort is by a process of censoring, which attempts to confine the data used in the analysis to data which might properly contribute to it. The symmetry or assessable skewness of a Normal Distribution demands that appropriate censorship criteria are used at both the upper and the lower ends of the age range. There is considerable dissent between experts, apparent in the present applications, as to how censoring should properly be done and whether Professor Roberts' method is effective or accurate. Be that as it may, predictions of age based on the fact that an individual has achieved stage H in all his teeth, and his lower left third molar in particular, have been produced and apparently widely used.

22. In the previous discussion it has been assumed that no development takes place beyond stage H. In recent years attention has been given to determining whether teeth which have reached stage H show any further signs of maturation. The result has been the identification of three separate "mandibular maturity markers". As their name suggests, these are not strictly directed to the teeth, but to the lower jaw (mandible) in which they sit. The examinations have been confined to cases where the lower left third molar has attained stage H. It is not clear whether the markers described are dependent upon the achievement of stage H or whether any of them may be observed in relation to earlier Demirjian stages.

23. The three proposed mandibular maturity markers are as follows.

24. First, Root Canal Width. This marker proceeds upon the assumption that following the attainment of stage H, the width of the root canals, as perceived on the tomograph, narrows in each tooth. The assessment of root canal width is a comparison of the perceived widths of the root canals in all three lower left molars. Three stages or grades are described. In grade 1 (or A), the widths of the root canals in the first molar are less than those in the second molar, which in turn are less than those in the third molar. At grade 2 (or B) the widths are the same for the first and second molars, but narrower than the third molar. In grade 3 (or C) the root canal widths are the same in all three molars. The database available to Professor Roberts enabled him to examine root canal widths in about a thousand tomographs. Using the criteria I have set out, he found that the minimum age of the attainment of grade 3 (C) in that population was 18.45 years for females and 18.16 for males. Surprisingly, the minimum age of attainment of stage B was 18.29 for males. There is no published account of this anatomical phenomenon or (therefore) any published reaction to it, but a paper by Professor Roberts and others was presented to the American Academy of Forensic Science in February 2016 and

a revised version of it has been accepted for publication in the Journal of Forensic Sciences. [3]

25. The second mandibular maturity marker is Root Pulp Visibility. This is based on an analysis of the appearance of the root pulp in the lower left third molar. At stage A the pulp is visible along the whole length of both root canals, at stage B it appears to have retreated in one canal but not the other; at stage C it has retreated almost fully in one canal and begun to retreat in the other; at stage D the root pulp is not visible in either root canal. It is (so far as I understand Professor Roberts' oral evidence) not clear whether this phenomenon is a result of dental change, or of maturation and perhaps greater opacity of the mandible.

26. This marker was first published by Olze and others in 2010 [4] in a reference data set of about 1200 individuals. They found that the minimum age for the attainment of stage C in females was rather over 23 years and in males rather over 22 years (I have summarised the results in that way because of the distribution of individuals amongst the various stages). A further examination of root pulp visibility was published by Pérez-Mongiovi and others in 2015 [5]. Their data set consisted of much smaller population. The minimum age of attainment of stage C was 18.8 years in females and 18.1 years in males. The authors concluded that their analysis does not wholly support the analysis of Olze, but that stage D (which, like Olze, they call "stage 3", their scale being 0, 1, 2, 3) can be used as indicating that females are over 21 but that "in males, other markers should be used". Professor Roberts' analysis is of about a thousand individuals, but, as it happened, the overwhelming majority were at stages A or B. The minimum ages for the attainment of stage C were 18.58 in females and 18.16 in males and of stage D 22.45 in females and 20.19 in males. The arithmetic mean was over 23 years old in each of those four cases, with (again in each case) an error margin represented by the inter-quartile width of about a year each way. The data for stages C and D, were, however, limited to 49 females and 75 males. Dr Lucas (who works with Professor Roberts and is in fact his wife) and others, including Professor Roberts, have submitted a paper [6] presenting these results and suggesting that root pulp visibility provides a clear indication of whether or not subjects are below or above 18 years old.

27. The third mandibular maturity marker is Periodontal Ligament Visibility. It will be remembered that the description of stage H includes a reference to a periodontal ligament of uniform width around the tooth, but without reference to its visibility. The x-ray visibility of the periodontal ligament or membrane reduces progressively as the tooth (again, in particular, the lower left third molar) settles into position. Radiographically, a visible ligament appears as a space between the tooth and the mandible. The stages are A: 100% of the ligament visible (that is, the space appears all around the tooth); B: 75-50% of the ligament visible; C: 50-25% of the ligament

[3] Roberts *et al*, "Dental Age Estimation: Pattern Recognition of Root Canal Widths (RCW) of Mandibular Molars. A Novel Mandibular Maturity Marker (MMM) at the 18 Year Threshold", Journal of Forensic Sciences, submitted 2016.

[4] Olze A *et al*, "Evaluation of radiographic visibility of the root pulp in lower third molars for forensic age estimation in living individuals". International Journal of Legal Medicine 2010; 124: 183-186.

[5] Perez-Mongiovi *et al*, "The radiographic visibility of the root pulp of the third lower molar as an age marker", Forensic Sci Med Pathol [2015] 11:339-344

[6] Roberts *et al*, "Dental Age Estimation – Root Pulp Visibility (RPV) Patterns: A Reliable Mandibular Maturity Marker at the 18 Year Threshold"

visible; D: 0% of the ligament visible. Those are the stages proposed by Professor Roberts. The gaps between A and B and between C and D (for example, 85% and 20% do not fall within any of the described stages) are unexplained. In the pioneering paper on this topic, again by Olze and others[7] the stages are 0, 1, 2, 3 and the definition is in descriptive rather than numerical terms.

28. Olze examined about 1200 individuals and found that in every case the minimum age for the attainment of his stage 1 (= Roberts' B) was over 18 years. In a sample of nearly 500 Portuguese subjects Sequeira and others[8] were not able to confirm Olze's results precisely, but were able to conclude that the achievement of stage 3 in males suggests an age of more than 21 (the minimum was 19.1 and the mean 26.9), but that a different process would have to be used for the assessment of the age of females. Professor Roberts' analysis of about a thousand individuals from the database available to him showed a minimum of over 18 years in both sexes for the attainment of stages C and D, albeit only just over 18 for stage C and a little over 18 and a half in both sexes for stage D. The averages for those stages were over 22 and over 23 for both sexes and the inter quartile width between about one and about two years either side. A paper by Dr Lucas and others including Professor Roberts with the ambitious title "Periodontal Ligament Visibility – A Conclusive Mandibular Maturity Marker at the 18-year Threshold" is forthcoming in the International Journal of Legal Medicine.

29. It is perhaps worth observing in relation to Periodontal Ligament Visibility first that, as my description of the stages shows, the definitions are perhaps a little vaguer than in relation to the other markers, and secondly that the published data, in particular, those of Olze, show that the attainment of the final described stage is not necessarily to be regarded as a feature of youth. In the population examined, 135 females and 112 males were 35 or over, but only 115 female lower third molars and 145 male lower third molars were found at the most mature stage. (As the figures in the tables make clear, in many individuals both lower third molars were examined and the results presented).

30. A further sign of age, observable by clinical examination rather than by radiograph, is dental wear. In the present cases, Croydon have made it clear that they do not rely on dental wear as diagnostic of age, but in my judgment it has to feature in a general assessment of the evidence, not only because it is apparently used by some examiners, but because specifically Professor Roberts uses or has used it. The only authority to which I was directed is a 1975 paper by Akpata. [9] He used a scoring of dental attrition following the work of T R Murphy, who had studied aboriginal Australians. The scale runs from 0 to 10. Akpata's sample examined each of the molars (totalling 352 in all) available for examination in a population aged between 20 and 80. He found that in each age group the attrition score for the first molar would be higher than that for the others. He concluded, however, that there is "a

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[7] Olze A *et al*, "Assessment of the radiographic visibility of the periodontal ligament in lower third molars for the purpose of forensic age estimation in living individuals". International Journal of Legal Medicine 2010b; 124: 445-448.
[8] Sequeira *et al*, "Age estimation using the radiographic visibility of the periodontal ligament in lower third molars in a Portuguese population", J Clin Exp Dent. 2014: 6[5]: 546-50.
[9] Akpata E S, "Molar tooth attrition in a selected group of Nigerians". Community Dentistry and Oral Epidemiology, 1975; 3: 132-135.

very high degree of relationship between age and the mean attrition score for the first molar". The results are presented in a number of ways, including a graph showing selected mean attrition scores plotted against the age of the individual.

31. It is said that the progress of dental maturity is governed genetically, not by features such as wealth or nutrition. If it is governed genetically, the genetic make-up of the reference data sets may be of some interest. Indeed many authors specifically state that comparability is attainable only by reference to a comparable racial or ethnic group. This is clearly Professor Roberts' view. The assertion appears not only in his opinion for this case but in his chapter in the Encyclopaedia of Forensic and Legal Medicine [10]:

> "The primary data source for DAA should be a RDS based on a clearly defined racial or ethnic group."

32. Similar observations are found in Sequeira[11]:

> "These data concern only the Portuguese population, and for other populations specific–population data should be used",

and by Olze [12] who indicates that although no data on the ethnicity of the population he examines have been collected, it may be assumed to be almost wholly Caucasian. In terms of the progress of dental maturation this view is not, however, universally accepted. Pérez-Mongiovi, [13] gives a contrary view as follows:

> "The ossification rate can be affected by the socio-economic status of the patient, meaning that the use of x-ray standards on a person of a lower socio-economic status than that of the reference population usually leads to an underestimation of their age Still, similarly to other skeletal maturation methods, there is a low impact of ethnicity, allowing x-ray standards for forensic age estimation to be applied in different ethnic groups, regardless of the reference population sample".

Professor Liversidge, both in her written evidence before me and in her published work [14] considers that only small differences in average ages are attributable to ethnic differences.

33. It would be inappropriate in this section to comment further on that difference of opinion. It is, however, relevant to what follows that Professor Roberts has noted a difference in the average age of attainment for stage H of the lower left third molar in various geographical surveys. He records this as follows, the first being from his own research on the DARLInG database and the others from published research of other authors:

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[10] Second Edition, 2015: chapter entitled "Dental Age Estimation: Theory and Practice", citing for this proposition Senn, D. R., Weans, R. A., 2013 Manual of Forensic Odontology, fifth edition.
[11] Op. cit. (n 8)
[12] Op. cit. (n 7)
[13] Op. cit. (n 5)
[14] Liversidge, "Timing of human third molar formation". *Annals of Human Biology* 35: 294-321, errata in *Annals of Human Biology* 35: 452-453; (2008); Liversidge, "Similarity in dental maturation in two ethnic groups of London children", *Annals of Human Biology* 38: 702-715 (2011).

UK Caucasian	19.40
Kuwait	20.36
Israel	20.96
Korean (South)	21.10
Chinese (Han)	22.40

34. This is also the appropriate place to note that in a 2009 paper [15] Knell and others examined data available to them in Switzerland. They divided the sample into those from Switzerland and those from South Eastern Europe, including the Balkans and Turkey. It was found that the latter population achieved dental maturity about six months earlier than the Swiss population, although the sample was somewhat limited.

35. Finally, it is to be noted that in his paper on tooth attrition, Akpata says that:

> "For tooth attrition to be applied in age determination, the rate of wear must first be established for the community with similar diet and chewing habits".

REASONING FROM STATISTICS: DECIDING BY NUMBERS

36. In this section I consider some of the issues arising from an invitation to a judge to make findings of fact based on calculated probabilities. It is not necessary to undertake a full treatment of the issue, and it would be presumptuous to try. But a number of things said during the hearing drew attention to the scope for misunderstanding; and in a judgment that is supposed to give guidance it is therefore desirable to draw attention to these matters. In what follows I do not attempt to set out the basis of proof by induction or of the calculation of probabilities based on statistics. Instead, the two examples below, and the observations connected with them, are intended to illustrate some of the differences between the world of statistics and the world of the judicial fact-finder, and to alert judges to some of the alarm bells that ought to ring in their minds when they are asked to act on statistical evidence or to say that because analysis of a database can produce a probability of more than (or perhaps a good deal more than) 50% for a contested fact the judge should regard it as proved.

37. Suppose there are 100 young men in a room: they have a common feature – for example they play a particular sport at a particular level. Their ages are known, and recorded in years and months. In summary, two are 19 (ie having had their 19th birthday but not their 20th), eighty-four are 18, ten are 17, three are 16 and one is 15. The average (mean) age is 18 years 7 months (but as it happens no individual is of that age exactly). Now suppose that the records are all destroyed or become hopelessly confused, so that there is no way of knowing which person had which age. One person leaves the room and comes before a judge for age assessment.

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[15] Knell *et al*, "Dental age diagnostics by means of radiographical evaluation of the growth stages of lower wisdom teeth", Int J Legal Med [2009] 123: 465-469.

With no other information, what can be said (or 'found', to the civil standard) about his age?

38. Clearly he is not under 15, and equally clearly he is not over 20. A bookmaker (or statistician) could provide the betting odds that he is, for example, at least 18. Similarly, calculations could be made about the range of error and the likelihood of any particular error if it were to be decided that he has the mean age of 18 years 7 months (which we happen to know cannot be his actual age). But none of this will help to tell which of the hundred young men in fact came out of the door. We know that one was only 15, and there is nothing to suggest that the person who came out was not that one. Being told that the chances that a person leaving the room is over 18 are 86% (or whatever) does not help a bit.

39. Further, the statistical probabilities or odds calculated in such circumstances rely on the selection of one person to leave the room being random. If it turns out, for example, that after the loss of the records everybody was rushing to get out of the room, and the person in charge of the exit door said that the youngest should leave first, odds based on <u>random</u> exit are obviously worthless. In those circumstances the persons who leave first are highly likely to be a combination of (a) those who know they are amongst the youngest present; (b) those who, correctly or incorrectly, think they are the youngest present; and (c) those who know they are not amongst the youngest present, but think they can get away with claiming they are.

40. Most ordinary statistical calculation of probabilities depends on a number of basic assumptions. One is that the database accurately reflects the background from which the unknown fact whose probability is to be calculated has come. This factor is avoided in the above example by knowing that the person came out of the room. It is clear that if the prediction was to be about a 101st young man, who had not been in the room at all, but also plays sport at that level, assumptions would need to be made about whether the one hundred in the room represented all people playing sport at that level, so that facts about the hundred were to be taken as facts about the whole group.

41. The second basic assumption, made in many but not all mathematical calculations, is that the statistics being studied are distributed in a standard fashion, showing a 'bell curve', symmetrical about a central point which is both the mean (arithmetical average) and the median (half of the recorded figures are lower, and half are higher, than the median). If the curve is not symmetrical, meaningful calculations can still be made; but if the distribution is not of this form the calculations will not work. In the example of the young men in the room, if (instead of their age in years and months) the number of exact birthdays they had each had had been recorded, any hope of doing statistical calculations would be gravely compromised by any who gave figures between 3 and 5, having been born on 29 February. Steps would have to be taken to exclude or censor these figures before calculations could be made.

42. The third assumption, made in many simple and less simple calculations, but entirely inappropriate for many others, is that the event or fact whose probability is being calculated bears a random relationship to the records in the comparable

database. The calculation of probabilities of the age of the person who emerged from the room based solely on the known distribution of ages in the room only works if the person leaving the room is or can be taken to be chosen at random. If that assumption cannot be made the odds are wrong. If heights as well as ages had been recorded and if it were known, for example, that the person leaving the room was in the shortest twenty-five per cent, the calculation again could be made, of the probability of the person being over 18, *given that* he was in the shortest twenty-five per cent. But as is clear from the example about the youngest being told to leave first, the part of the calculation that is the 'given' may be incalculable or more or less so. The calculation of odds based on preconditions not precisely known is the realm of bookmakers and punters rather than statisticians, and bookmakers and punters do not always get it right.

43. One final point to make on this example is that if the statistical calculations of probability were to be relied upon to make a finding of fact in relation to age, it looks as though each of the people in the room, assessed separately, would be found to be 18 or over. We know that that would be incorrect in 14 of the 100 cases, although of course we would never know which.

44. Take another example. Suppose the resolution of a civil case depends on the question whether it rained in Little Marple, a hamlet in Gloomshire for which no detailed records are available, on 26 October 1999. The rainfall records for Gloomshire show that year after year there is rain on 25 of the 31 days in October. Based on that alone it is difficult to see that one would be justified in finding that it rained in Little Marple on 26 October; and even if the figures showed that there was more rain towards the end of the month that would not help very much. What the statistics would provide, however, is a matrix within which other evidence might be assessed. With so much evidence of October being a rainy month in Gloomshire, it might be easier to accept the evidence of an otherwise frail witness who said he remembered having to put his galoshes on to go out to dinner that night. If the month had been June and the evidence that rain in Gloomshire in June is exceptionally rare, the same evidence might not have been so readily capable of being accepted.

45. In that example, the thing to note is that the reasoning moved into quite informal language. Statistical probabilities can be combined with other statistical probabilities, but they are not amenable to precise combination with other forms of inductive reasoning. They can nevertheless provide a valuable matrix for the consideration of other evidence.

46. What is also apparent is that whereas for most purposes of the calculation of statistical probabilities the most informative data are measurably close to the mean, once the reasoning moves away from the mathematical to the judicial, it is the extremes that are likely to be most useful. The phrases used above were 'a rainy month' and 'exceptionally rare'. If the relevant month had been September, and the records showed that there is rain on 19 of the thirty days of September, it is perhaps unlikely that either that statistic or any probability calculated from it would be of any perceptible use in determining the issue.

47. The conclusions that may be drawn are warnings rather than guidance or instruction. First, figures produced may be misleading, and in particular the fact that an element of evidence is adduced in numeric form does not mean that it is entitled to be regarded as more persuasive. Secondly, if probabilities are presented, it is crucial to ensure that any factors counting against randomness have been properly factored in, and it is essential that the database used for the calculations is genuinely appropriate for the individual fact in issue. Thirdly, material derived from a database may be of considerable use if it shows that the fact claimed is impossible or highly unlikely; and in that context such material may assist in the assessment of the reliability of other evidence. Fourthly, an assessment of the probability of a basic fact about a person where that fact is plausible but unknown is unlikely to be assisted very much by a statistical probability doing little more than confirming plausibility. Fifthly, judges should be extremely cautious about accepting a submission that a calculated probability of a figure over fifty per cent means that a fact is proved to the civil standard. Judicial proof is a matter of persuasion, not mathematics; and the crucial question may well be: supposing I make a finding based on these figures, how likely is it that I shall be wrong and is that risk acceptable in the context of this case?

THE STATE OF KNOWLEDGE

48. In this section I intend to state my conclusions about what propositions can properly be derived from the available data that are relevant to the assessment of the age of a person whose age is unknown. The conclusions in this section are intended to be general: I deal with Professor Roberts' use of the material in the next section. In this section I deal first (A-C) with the possibility of predictions where the individual of unknown age has a similar ethnic background to the individuals surveyed in an available reference data set. I then turn at D to the additional issues raised by this process of age assessment where no such reference data set is available.

A. Where one or more teeth have not reached Demirjian stage H

49. Where there are immature teeth in the mouth, the simple average method described in section 3 above appears to be quite reliable. It is clearly more reliable if the number of immature teeth is greater: so it is more reliable if the individual is younger. The evidence on assessment at the 10-and 13-year old boundaries adduced by Professor Roberts was impressive: there was no specific discussion of it at the hearing but I did not receive the impression that the use of the simple average method based on a substantial database is the subject of serious dissent amongst the scientific community. It may be of limited assistance in age assessment cases, because the claimants are not usually young enough for there to be a substantial number of immature teeth to provide a potentially accurate prediction of age by this means. That is not, however, the end of the matter for age assessment purposes. One thing that is clear is that the earlier a tomograph is taken, the more likely it is to show immature teeth, and therefore the more likely it is that there will be scope for using data relating to immature teeth.

B. Where all teeth have reached Demirjian stage H

50. As dental maturity is a sign of general maturity, a great deal of attention has been paid to the possibility of predicting age from the fact of the acquisition of mature dentition. This poses considerable difficulties, as explained above. The age at which the individual achieved dental maturity is not normally known: all that can be said is that it was a date before the date of the x-ray. That error will operate to attribute an age younger than the true age (because the stage H data all relate to subjects older than the date of achievement of stage H): whatever may be thought about the desirability of that, it is an error nonetheless. More crucial is the fact that plotting age against number of individuals with mature dentition does not produce a symmetrical graph, because all individuals achieve mature dentition if they survive long enough to do so. Thus, calculations of probability based on standard deviations appear to have no application. One possible solution is the censoring of the data to confine it to an apparently relevant age group, but, as was demonstrated at the hearing, there is no universally accepted way in which this can be done. A further difficulty arises precisely because, for most individuals, dental maturity is achieved in the late teens, and the attribution of an age of above or below 18 by this method is therefore extremely hazardous: the eighteenth birthday is likely to be within the margin of error of the prediction. Indeed, in a recent paper [16] Professor Roberts with others concluded that the prediction of whether a person had achieved his or her eighteenth birthday based on all teeth being seen at Demirjian stage H would be wrong almost as often as it was right: as he put it, the process was no better than tossing a coin. I shall have to refer to this paper again in the next section.

51. Despite these considerations, it is clear that dental maturity is one of the markers of general maturation and hence of a chronological age likely to be in the latter half of the teens. What is likely to be more persuasive than a calculation based on the inter-quartile width is a basic statement of the minimum age of a person with mature dentition observed in the database, perhaps with some indication of the number of individuals in the year of age each side of that. That material might, in an appropriate case, lead to an observation that no individual of the appellant's claimed age (or, only a tiny minority of individuals of the appellant's claimed age) had been observed with mature dentition. But unless the case permits an observation of that strength, it may well be that the mere fact that an individual's teeth are all at Demirjian stage H can contribute little to the determination of whether he or she has obtained the age of 18 years: it merely confirms the plausibility of that hypothesis.

C. The Mandibular Maturity Markers.

52. This is a developing field. Despite the confidence expressed by Professor Roberts I am wholly unpersuaded that any of the mandibular maturity markers is as yet backed up by sufficient expert analysis to be reliable as an indicator of age.

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[16] Lucas *et al*, "Dental Age Estimation: A Test of Reliability of Correctly Identifying a Subject over 18 Years of Age Using the Gold Standard of Chronological Age as a Comparator" Journal of Forensic Sciences 2016.

53. Although two of the Markers (Root Canal Visibility and Periodontal Ligament Visibility) have been the subject of papers other than by Professor Roberts and his colleagues, the results (in particular the predictions of age derived from them) show little agreement. There are obviously several possible reasons for this. One may be that the samples are not yet large enough. One may be a difference in ethnic background (a matter to which I return in general later in this section). A further possibility is that the authors of the different papers were not observing precisely the same phenomena: although each paper is based on a cross-checking of the comparability of the observations being made, there does not appear to have been any checking between the authors of the different papers, and where in a new field comparatively isolated analyses occur there may be little opportunity for precise comparison of the opinions of the different analysts. Professor Roberts and his colleagues are in the process of contributing to the literature on each of the three markers: one, Root Canal Width, has, so far as I am aware, been observed and analysed by the DARLInG team only. Although all the papers have been accepted for publication, none of them has yet been subject to debate: acceptance for publication indicates that the hypothesis of the paper is respectable: it does not mean that it is correct. I am therefore unable to share the confidence expressed in the title of the paper by Professor Roberts and his colleagues in relation to periodontal ligament visibility, and in general it does not appear to me that it is yet right to allow determinations of age to be based too firmly on any of the Mandibular Maturity Markers.

54. Nevertheless, it may well be worth collecting data on them, in case, as knowledge develops, assessments of age based on them become more clearly reliable.

D. Ethnic Background

55. I now turn to the issue of the ethnic make up of the various available reference data sets. The view that ethnic background is of little effect or importance in the relationship between chronological age and dental maturation is, as I have said, held by some authors, but it is very far from easy to accept. The available data mentioned in the table in para 33 above appear at least to show that dental maturation in some far eastern populations is achieved later than in white Caucasians in the DARLInG database. This introduces a further likelihood of error into age assessments based on any given reference data set, unless the individual being assessed is of the same ethnic background as the members of the reference data set.

56. There is no reference data set for young Afghan males. The dates of birth are not officially recorded in Afghanistan, and it has therefore been assumed that it would be impossible to compile a database including analysed dental tomographs of Afghans of known age. I am not confident that that assumption is correct. It is true that births are not recorded in Afghanistan, but, (given that the determinant is ethnic background rather than place of birth) it is not clear why attention has not yet been given to those of Afghan parentage born in other countries where records are kept, for example, Russia, Pakistan and western countries. There appear, indeed, to be no available large reference data sets of any comparable racial or

ethnic group, which is somewhat surprising[17]. In the circumstances it is difficult or impossible to ascertain the error introduced by use of a reference data set composed of individuals of an ethnic background different to that of an Afghan individual being examined. The level of potential uncertainty appears to be high: there is not, for example, any obvious reason for supposing that the data for unexamined ethnic groups falls within the limits so far ascertained in examined ethnic groups.

57. So far as concerns dental attrition, the authoritative paper by Akpata, to which reference is made in section 3, makes it clear that deductions from observed tooth wear depend on a knowledge of the diet and chewing habits of the relevant population. There appears to be no evidence that any other population has diet and chewing habits similar to those in the population analysed by Akpata.

PROFESSOR ROBERTS' OPINIONS

58. Professor Graham Roberts currently holds a position of Visiting Professor at King's College London. His clinical and academic activities continue vigorously following his retirement from full-time employment. His career in clinical dentistry and dental pathology has been extensive and distinguished. He is the author or joint author of numerous articles and parts of books, for the most part on dental pathology and related topics but his curriculum vitae (running to 38 pages in the copy provided to the Tribunal) includes some 30 articles related to dental age assessment. All but 6 have been published since 2010. The journals of publication range from the British Dental Journal and the Journal of Forensic Science to the Indian Dental Association Times. His knowledge and expertise are beyond question. They were demonstrated at the hearing, as also, if I may say so, were his teaching abilities: he was able to put across complex concepts in a way that enabled them to be understood by mere lawyers. He has in the past few years, perhaps largely since his retirement from a full-time Chair, made dental age assessment his particular speciality. His knowledge of this area, its scientific background and the research literature, is encyclopaedic.

59. He has also provided, either alone or jointly with Dr Lucas, over 650 dental age assessments. A sample of such an assessment is attached to his written expert report.

60. The present applications by Croydon relate not only to the acquisition of dental maturity data from the individuals who have brought these claims: they seek also an order that they be allowed to rely on Professor Roberts' opinion evidence. It is therefore of some importance to determine not merely whether the techniques of dental age assessment are sound, but whether Professor Roberts' opinion in relation to individual cases is reliable. Thus, during the hearing, considerable attention was paid to the sample report provided by Professor Roberts and to setting that report in the context of the other evidence, including his own evidence about his own views of areas some of which are controversial. Typically, a social worker or a

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[17] There are published data for younger teenagers of Indian, Pakistani, Bangladeshi and (perhaps) Iranian ethnicity: see Jayaraman *et al*, "The French-Canadian data set of Demirjian for dental age estimation: A systematic review and meta-analysis", Journal of Forensic and Legal Medicine 20 (2013), 373-381.

Court or Tribunal will have the raw data interpreted in the form of a report such as that exhibited by Professor Roberts. It is therefore important to know whether the views expressed in such report can be accepted on the faith of the knowledge of the author of the report, or whether it is proper to have any reservations about them.

61. The sample report is anonymised: in what follows "X" represents the redacted name of the individual. The part of the report dealing with age assessment is in the following terms:

"A. Stage of Development of the Lower Left Third Molar

The feature of note on the radiograph of X is that the lower left third molar is at stage H (LL8Hm) in its development. This means that it is completely formed and will not develop further. The lower right third molar is a mirror image of the lower left third molar. For age estimation purposes it is appropriate to consider only the LL8.

The data for this stage of the development in males indicate that on average, the subject is 19.40 years old. The middle 50% of the data (the inter quartile width) ranges from 18.10 years to 20.91 years – a span of 2.81 years. The probability that X is under 18 years is 0.2037. The corollary to this is that the probability that X is over 18 years is 0.7963 (79.63%).

The plain English version may be stated as "X is likely to be 19.40 years plus or minus 1.405 years".

B. Root Pulp Visibility

A further biological marker is the loss of visibility of the Root Canal Pulp as discerned on the Dental Panoramic Tomograph [radiograph of all the teeth visualised on a single x-ray].

The youngest that X could be using this parameter is 25.2 years.

C. Periodontal Ligament Visibility

An additional biological marker is visibility of the periodontal ligament discernable on a Dental Panoramic Tomograph.

The youngest that X could be using this parameter is 26.2 years.

D. Tooth wear

The wear discernable on the occlusal (biting) surfaces is a clear indicator of an age over 20 years. The wear has been assessed using the criteria described in Nigeria.

This gives an age assessment of 27 years.

Plain English explanation

The data available related to these four methods of estimating age indicate very strongly that X is 19.4 years or more. The information available on
    B. Root Pulp Visibility,

C. Periodontal Ligament Visibility, and

D. Tooth Wear indicates that there is very strong likelihood that X is over 25 years old.

There remains the question of the role played by ethnicity in growth and development of the teeth. [There is then an introduction to the figures set out in the table in para 33 above, and those figures are given].

It is clear that the further east from the prime meridian, the higher the average age for the attainment of stage H of the lower third molar i.e. completion of root growth."

62. References are given to a 2010 paper by Lewis and Senn on assessment of age using the development of the third molar and to the papers by Olze and Akpata and to the *Encyclopaedia* chapter, to which I have already referred[18], but no further explanation is given and no other reservations are stated. The date of this sample report has also been redacted, save for the year, which is 2015. The individual was of Afghan origin.

63. That report invokes four separate methods of age assessment based on the appearance, radiographic or morphological, of the subject's teeth. Each one of the four assessments raises, in my judgment, considerable concerns, contained as each of them is in a report from Professor Roberts in 2015. (That is to say, the earliest possible date of the report is 1 January 2015; the latest possible date is 31 December 2015; there is no more precise information about the date of the report.)

64. First, the report communicates an assessment of age based on the fact that the lower third molars are at Demirjian stage H. As I have already said, that is a process of age assessment that is or has been used widely. So far as Professor Roberts is concerned, however, he and Dr Lucas (the other signatory of the report under examination) submitted their paper casting very serious doubt on the reliability of age assessment by this method to the Journal of Forensic Sciences on 7 July 2015. That means that for the second half of the year Professor Roberts is on record as holding the view expressed in that paper, which is that the assessment of whether a person is over or under 18 by the use of this method is not much better than tossing a coin, as he put it in his evidence. But, of course, neither the research, nor the writing of the paper, nor its preparation by four nominal authors for publication, can have been done instantaneously. The truth of the matter is that this view must have been adopted by Professor Roberts considerably before the date of the submission of the paper. Bearing in mind the previous history of age assessment by this method, the very undertaking of the research suggests that the authors of the paper were sceptical about the accuracy about that method. In short, I regard it as in the highest degree unlikely that at any date in 2015 either Professor Roberts or Dr Lucas held the view that the first method of age assessment used in their report was reliable. But there is no suggestion of that in their report itself. Mr Wise pressed Professor Roberts on this at the hearing. Professor Roberts did not say that this

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[18] Lewis JM, Senn DR. "Dental Age Estimation utilizing third molar development: a review of principles, methods, and population studies used in the United States". Forensic Science International 2010; 201(1-3):79-83; see also notes 4, 7, 9 and 10 above.

showed that the report must have pre-dated his suspicions or research: he simply said that this was a method that was frequently used.

65. I should say also that, at the hearing, Professor Roberts was clear that he no longer uses the attainment of stage H in all teeth as a measure of age: instead, the attainment of stage H in all teeth is simply the borderline between the use of the simple average method (available if not all teeth have reached stage H) and the mandibular maturity markers when all teeth have reached stage H.

66. The second method of age assessment in the report under examination is Root Pulp Visibility. In this part of the report, there is no indication of the stage said to be observed, but the statement that the youngest that the subject could be using this parameter is 25.2 years, with a reference to Olze's paper, indicates that the stage was stage 3. There is no reference to the fact that there had been no confirmation of Olze's data. On 24 June 2015 Pérez-Mongiovi's paper was produced, giving a minimum age of 19.1 for the attainment of the same stage in males. Clearly if (but only if) the report under examination was produced in the first six months of the year, one could not expect a reference to the latter paper. The report is, however, produced as an appropriate sample attached to Professor Roberts' evidence dated 6 September 2016. There appears to be no suggestion that it would be appropriate either to refer to the different implications arising from the Pérez-Mongiovi paper, or to offer any recognition that the difference in the results of that paper and the Olze paper may cast doubt on the accuracy of age assessment based on the data in either of the papers.

67. The third method used in the report under examination is Periodontal Ligament Visibility. Here, using the same method of interpretation, it can be ascertained that the subject had attained stage 3, and Olze's figures are passed on to the reader of the report without comment. The paper by Sequeira and others was accepted by the Journal of Clinical and Experimental Dentistry on 26 July 2014, and published in the last number for 2014. It was thus available to anybody writing a report in 2015. The minimum age for a male exhibiting stage 3 development according to that paper is 19.1 years. Here, because the paper came out before the report, it must be regarded as even more surprising that there are no references to it or to the danger of relying on Olze's figures.

68. There is a further difficulty in the use of two separate Mandibular Maturity Markers. In summarising the work done on them so far, I noted the apparent lack of any evidence that any of the three Mandibular Maturity Markers are dependant upon the attainment of Demirjian stage H. It is also true, however, that there does not appear as yet to be any examination of whether they are independent one of another. Each of the published analyses to which I have referred deals with one of them: I was not referred to any analysis of two or three of them in conjunction. This is relevant for the following reason. If in any individual they are independent one of another, they provide separate pieces of information, each of which may (if this method is reliable at all) provide assistance in assessing the age of the individual. If, however, the one or more of the ways in which the development of maturity has apparently been detected is dependent upon another, that is to say if they operate in parallel in each individual or (in particular) if any of them is caused by any of the

others, then although a second Mandibular Maturity Marker observation will help to confirm the accuracy of the first, the two together say no more than one. In the report under examination, root pulp visibility and periodontal ligament visibility are treated as though they are separate indicators of age. I do not think that there is any proper basis for that: so far as I have been told, they may only be separate confirmation of a more general notion of mandibular maturity.

69. The fourth age assessment method relied on by Professor Roberts in the report is Tooth Wear. Here it is said that the wear observed is a clear indicator of an age over 20 years, with an estimate of 27 years based on Akpata's paper. As I have already indicated, Akpata's paper contains a warning not to use tooth wear as an indicator of age without knowledge of the nutrition and chewing habits of the population under examination. Anybody reading Akpata's paper and thinking that Professor Roberts was reliable would no doubt assume that Professor Roberts had appropriate data for the age assessment of an Afghan male by tooth wear. In fact, that is not the case. The lack of such data does not, however, discourage Professor Roberts from making an estimate. As he said in the course of his evidence, it is appropriate to make an assessment on the data that are available. That applies, apparently, even if the data are not shown to have any relevance at all to the subject being examined.

70. So far as ethnic variation is concerned, Professor Roberts was insistent in his evidence that he himself makes no adjustment: what he does is to set out the available data for different populations. That, as has been seen, is what the report under examination does. However, the report goes further: it asserts that "it is clear that the further east from the prime meridian, the higher the average age for the attainment of stage H of the lower third molar, i.e. completion of root growth". That was a view upon which Professor Roberts also expanded at the hearing. If the assertion in the report is right, it would imply that an assessment using the DARLInG database would underestimate the age of anybody east of London.

71. The assertion by Professor Roberts in the report, however, bristles with difficulties. The first is that, both as expressed and as potentially derived from the data cited, it could apply only to the attainment of stage H of the lower third molar, which is, in Professor Roberts' view, not reliable anyway. Secondly, the assertion does not even match the available data. Not only does it ignore the fact that Israel is not east of Kuwait but over a thousand kilometres to the west; it also ignores the data in the paper by Knell and others, who found, as noted above, that south east Europeans were about six months ahead of Swiss. Thirdly, there does not in any event seem to be any good reason for supposing that the relevant ages for Afghan males would be something between Israelis and Koreans: there was no ethnological basis for such view cited before me. It may be, therefore, that Afghan males obtain dental maturity earlier than those in the DARLInG database, or later than Han Chinese: one simply cannot say. Fourthly, although the influence, if any, of ethnicity is indeed said to be genetic, the research giving rise to the figures cited appears, at least in part, to be derived from populations available in the quoted geographical localities, rather than populations carefully sorted by ethnicity. There is, so far as I am aware, no reason at all to suppose that the rate of tooth development is affected by the geographical location of the subject.

72. The figures quoted in Professor Roberts' opinion do not support the assertion he makes immediately after quoting those figures; that assertion has no other support. The rate of maturation of teeth in the Afghan male is at present a matter on which there are no data and on which there is no proper basis for supposition. I appreciate that, as noted above, there are experts who regard the role of ethnicity as minor. If they are right, the lack of data for Afghan males is much less of a problem. The point here, however, is that Professor Roberts is not one of those experts. He thinks it does make a difference, but he is prepared to make what really amount to wild guesses about what difference. When he was asked about this at the hearing he again said that you have to work on the data that you have.

73. Mr Wise QC suggested, by his questions, that the sparsity of information in Professor Roberts' opinions was deliberately designed to prevent them being read critically and therefore possibly to deceive a reader. I am not persuaded of that. It does, however, seem to me that Professor Roberts has developed an attitude of omniscience, in which he is prepared to assume that what he says goes. Coupled with that, he seems to be prepared to base apparently precise assessments on material which simply cannot support those assessments. The most alarming example of this in the report under examination is obviously that of tooth wear. Croydon's assertion that they do not rely on tooth wear does not help: the point is that Professor Roberts was prepared to express this opinion in a formal age assessment report. The difficulties in relation to the other age assessment methods in the report are more subtle, but they are of the same nature. In relation to each of the four age assessment methods, there was reliance on unreliable data, or failure to mention difficulties about use of the data, or both. In the circumstances I have, with the greatest regret, reached the conclusion that an assessment in this form (or anything like it) by Professor Roberts should be read with the greatest of caution and should be acted on only if there has been a proper explanation of the basis for the opinions expressed.

THE DANGERS OF X-RAY TOMOGRAPHY

74. The exposure of an individual to x-rays during the process of making the dental tomograph used in age assessment creates a small but measureable risk of the development of cancer. The risk is variously assessed and is agreed to be comparable to that undergone in international flight. Although when the present applications for judicial review were commenced, the applicants invoked the risk as one of the reasons for them not to undergo age assessment based on dental tomograph, by the time of the hearing before me it was agreed between the parties that the risks were small and the applicants no longer sought to rely on this argument.

75. The British Dental Association takes the view that dental examination does not produce an accurate assessment of age, and that it is unethical to expose an individual to a dental x-ray where there is "no direct health benefit". That view is obviously entitled to the highest respect, but in my judgment it is too narrowly based. First, I am satisfied that the information obtained by a dental tomograph may in many cases provide some assistance in age assessments: there may be other

cases in which it provides information which is virtually diagnostic on whether the individual has or has not passed a particular age. Secondly, the correct assessment of age enables an individual to receive the appropriate support when growing up, to be categorised as ready or not yet ready for work, to obtain the appropriate level of benefits, and in all other ways to be treated in an appropriate manner by the society in which he finds himself. It is thus of the very greatest benefit both to the person in question and to the public as a whole that, where age is disputed, it should be, so far as possible, assessed correctly.

76. Taking all those factors together, it seems to me that, generally speaking, the invocation of the risk deriving from exposure to x-rays will not be a good reason for an individual whose age is disputed to refuse to undergo the process leading to the production of an x-ray dental tomograph. There may, of course, be cases where the individual can show that, for some special reason, the risk in his case is higher, and that may demand separate consideration. But there is no suggestion of that in either of the two applications before me.

CONCLUSIONS

77. I draw the following general conclusions about dental development as an aid to age assessment.

    (1) The description of dental maturity by reference to the Demirjian stages appears to be widely-used and useful. It is of very limited use for age assessment when all or very nearly all teeth have reached stage H and the fact that all teeth have reached stage H is not of itself sufficient to be a guide to whether a person is or is not over the age of 18.

    (2) None of the three Mandibular Maturity Markers described in this judgment has yet been sufficiently examined to enable it safely to be said that it is diagnostic of age. Further work is needed on the comparability of the data from different studies and the causes of the presentation of the markers and their independence one of another, as well as a wider range of acceptance in the relevant scientific community.

    (3) Dental wear may in some circumstances help to establish age but only if data for a population with similar diet and chewing habits are available.

    (4) The relevance of ethnic background to the progress of dental maturity is not yet clear.

78. In that context there is obviously room for doubt whether dental evidence should be received in age assessment cases. It seems to me that as long as there is no risk of its being over-valued it is or may be of use at the present time. Further, in this very active field of research, it may be that the relevance of ethnic background may be decisively shown to be negligible, which would enormously widen the range of reference data available to every investigator. And further investigation and more published research may establish the reliability of one or more of the Mandibular

Maturity Markers. In the mean time, and despite all the reservations, a dental tomograph may provide information making a claim extremely likely or extremely unlikely, and may identify features of assistance between those extremes.

79. I therefore offer the following guidance

    (1) Evidence obtained by x-ray dental tomography may well be relevant to age assessment.

    (2) Generally speaking, the danger to an individual arising from exposure to x-rays in the tomography process is wholly outweighed by the intended benefit of a contribution to the evidence used in age assessment. It is likely to be unreasonable for a young person whose age is disputed to refuse to undergo the process, or for a refusal to be entered on his behalf. The earlier a tomograph is taken, the more likely it is to offer useful information.

    (3) Judges should beware of being misled into over-valuing statistical evidence in the context of a fact-finding exercise. They should bear in mind the risks of error and consider in an individual case whether that risk is tolerable. They should be prepared to question the assumptions behind statistical calculations and ensure that the reference data set is valid and that all factors capable of affecting the calculations have been taken into account.

    (4) Judges should be prepared also to question the basis of opinions expressed in a report or opinion. Opinions sharing major features with that examined in the present judgment are unlikely to be worthy of reliance, and judges should be wary of accepting age assessments that appear to rely extensively on the reputation of the author rather than the detail, consistency and currency of the data.

80. Following the hearing Croydon accepted the age claimed by ZM and his application for Judicial Review was withdrawn by Consent Order. The claim by SK continues.

C M G Ockelton

C. M. G. OCKELTON
VICE PRESIDENT OF THE UPPER TRIBUNAL
IMMIGRATION AND ASYLUM CHAMBER
Date: 11 November 2016