Anne Mowbray and the Princes in the Tower: a study in identity

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THE PUBLICATION OF Professor Warwick's observations on the skeleton of Anne Mowbray[1], a contemporary and relative of Edward V and of Richard, Duke of York, allows us a rare opportunity to reassess the attribution to the Princes in the Tower of the two skeletons studied by Tanner and Wright[2] (Fig. 1).

To test the attribution we might look for evidence on three counts:
1) that the skeletons are those of males
2) that the skeletons shows signs that they are of closely related individuals
3) that the difference in age between the two skeletons is about three years since Edward, born in November 1470, would have been two years nine months older than his brother, Richard, if the latter had been born in August 1473.

1. Sex determination

Sex determination of juvenile skeletons is notoriously unreliable. The teeth are the only area that offers a method of sexing with any degree of confidence. Once formed, the permanent teeth do not grow, and erupt even in a six year old child at their adult size. If the adult teeth are of differing sizes in the two sexes, then these differences can be used to determine the sex of juvenile material. Unfortunately we have neither the dimensions of the teeth nor an adult sample with which to compare them.

The relative development of the different teeth differs in the two sexes. In a girl the canine tooth erupts shortly after the roots of the lateral incisor and first molar are completed. In a boy eruption of the canine takes place a year after the completion of the root of the lateral incisor.

The canine of the mandible of the younger child is not ready to erupt, although the incisor and first molar roots are complete. This suggests that it might be a male.

1. R. Warwick 'Anne Mowbray: the skeletal remains of a medieval child' *London Archaeol* **5**, no. 7 (1986) 176-9.
2. L. E. Tanner and W. Wright 'Recent investigations regarding the fate of the Princes in the Tower' *Archaeologia* **34** (1934) 1-26.
3. E. Hunt and I. Gleiser 'The estimation of age and sex of pre-adolescent children' *Amer J Phys Anthrop* **13** (1955) 79-87.

In order to attempt a sex determination of the older child, both dental and skeletal maturity have to be considered. Puberty occurs about two years earlier in girls than in boys. Although the actual age of puberty differs in different populations, the age difference between the sexes is usually maintained. There are certain dental and skeletal stages that correlate with the onset of puberty. In girls the canines, premolars and second molars have usually erupted *and* the epiphyses of the wrist and hand have fused. In the older child although the canines, premolars and second molars have erupted, the ulnar and metatarsal epiphyses have not yet fused. The indications are that the skeleton is of an adolescent boy who has not attained puberty.

These suggestions that the two skeletons are of boys are not contradicted by the rubicon put forward by Hunt and Gleiser[3], that 'if dental age and skeletal age correspond the skeleton is that of a boy but

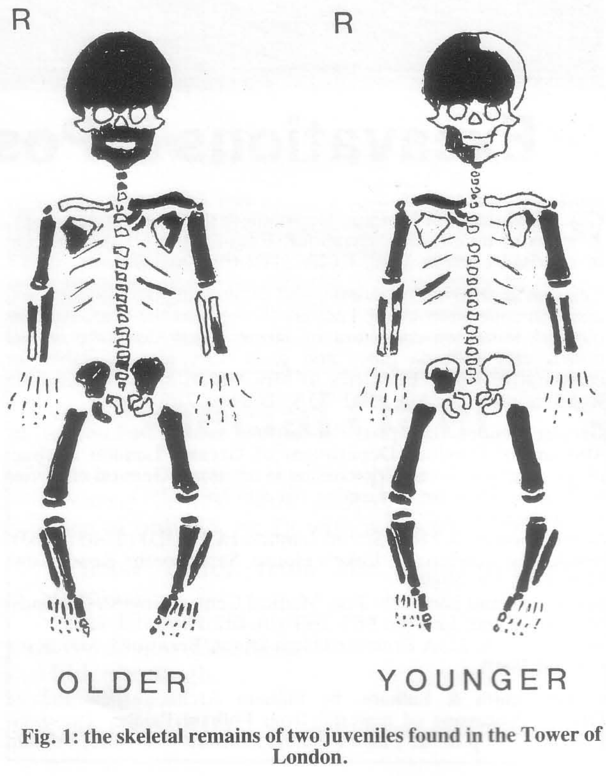

Fig. 1: the skeletal remains of two juveniles found in the Tower of London.

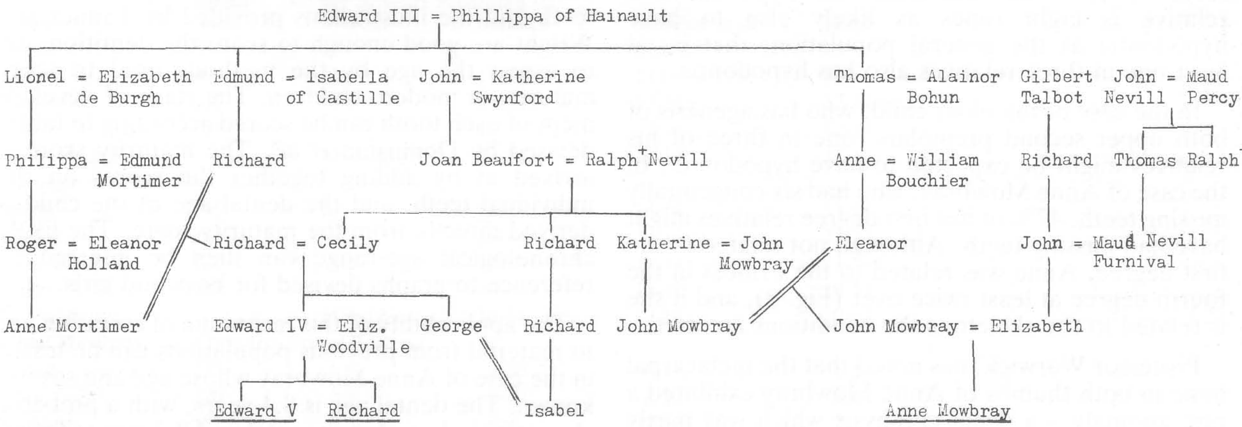

Fig. 2: part of the genealogy of the Princes, sons of Edward IV, and of Anne Mowbray. Their great, and great great grandparents were Joan Beaufort and Ralph Nevill, and Maud Percy and John Nevill.

should the age from the bones have been in advance from that of the teeth it is more likely to be female'. In neither case is the skeletal development, as distinct from size, ahead of the dental.

2. Evidence for consanguinity

The part of the genealogy of Anne Mowbray and the Princes depicted in Fig. 2 shows how closely the three children are related. In seeking evidence that the individuals represented by the skeletons from the Tower might have been related to each other or to the known relatives of the princes, there are a number of skeletal traits that can be examined.

Large extra ossicles or wormian bones are present in the lambdoid sutures of both skulls of the skeletons from the Tower. Although wormian bones were noted in 20-43% of the skulls from the medieval cemetery at Winchester, the similarity of the ossicles in size and position on the suture line of the two skulls is strongly suggestive of relationship.

The permanent dentitions of the older child and of Anne Mowbray are incomplete (Fig. 3). The prevalence of missing permanent teeth in a British sample is 3.1% in boys and 5.7% in girls[4]. The frequency of upper molar agenesis in the same sample was 0.8%. This is the same frequency (0.86%) as was found in the medieval Winchester sample, so it is unlikely that the population frequency for hypodontia as a whole was very different for an English population of the past.

Brook[4] has recently reported that agenesis occurs more often among first degree relatives of an individual with hypodontia than in the population as a whole. Females are more likely to be affected than males. This suggests a considerable inherited component in the aetiology. In Brook's study, 30% of first degree relatives of an individual with hypodontia of 1-5 teeth also had hypodontia, and 47% of relatives with hypodontia of six or more

4. A. H. Brook 'A unifying aetiological explanation for anomalies of human tooth number and size' *Archs oral Biol* **29** (1984) 373-8.

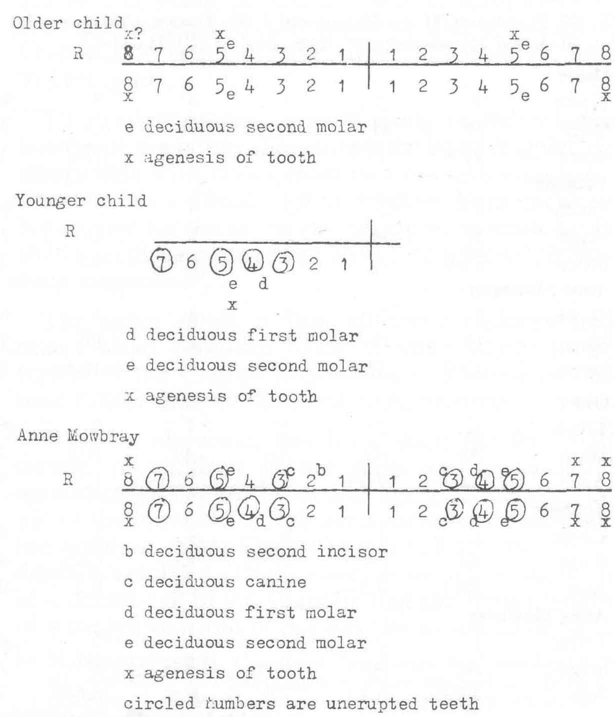

Fig. 3: dental formulae of the juveniles from the Tower and of Anne Mowbray.

teeth. Thus if an individual has hypodontia, a relative is eight times as likely also to have hypodontia as the general population; that is, at least one in three relatives also has hypodontia.

In the case of the older child, who has agenesis of both upper second premolars, one in three of his relatives might be expected to have hypodontia. In the case of Anne Mowbray, who had six congenitally missing teeth, 47% of her first degree relatives might have had missing teeth. Although not related in the first degree, Anne was related to the Princes in the fourth degree at least twice over (Fig. 2), and if she is related to the skeletons the conditions are met.

Professor Warwick[5] has noted that the metacarpal bone in both thumbs of Anne Mowbray exhibited a rare anomaly – a distal epiphysis which was partly fused to the shaft of the bone. The first metatarsals of the older child as illustrated by Tanner and Wright also appear to exhibit a distal epiphysis partly fused to the shaft of the bone[6].

3. Age at death

The age at death of a juvenile is best deduced from a study of the teeth. A detailed study of the teeth of Anne Mowbray including radiographs has been published[7]. Similarly the descriptions of the teeth and the illustrations provided by Tanner and Wright are good enough to score the dentition and to assess the age by the methods used to score maturity in modern children. The stage of development of each tooth can be scored according to tables devised by Demirjian *et al*[8]. The maturity score is arrived at by adding together the scores on the individual teeth, and the dental age of the child is derived directly from the maturity score. The likely chronological age-range can then be inferred by reference to graphs devised for boys and girls.

The applicability of this technique of assessing age to material from previous populations can be tested in the case of Anne Mowbray whose age and sex are known. The dental age is 8.4 years, with a probable chronological age between 7.7 and 9.2 years. This is compatible with her known age of 8 years and 11 months (Table 1).

The teeth of the older child from The Tower, as described by Tanner and Wright, yield a maturity score of 97.0, giving a dental age of 14.4 and a chronological age between 12.9 and over 16 years. The teeth of the younger child yield a maturity score of 87.0, giving a dental age of 9.6 and a likely

5. *Op cit* fn 1.
6. *Op cit* fn 2, Plate V, Fig. 4.
7. M. A. Rushton 'The teeth of Anne Mowbray' *Brit Dent J* **119** (1965) 355-9.
8. A. Demirjian, H. Goldstein and J. M. Tanner 'A new system of dental age assessment' *Hum Biol* **45** (1973) 211-27.
9. J. F. Gravely and D. B. Johnson 'Variation in the expression of hypodontia in monozygotic twins' *Dent Pract dent Rec* **21** (1971) 212-20.
10. C. F. A. Moorrees, E. A. Fanning and E. E. Hunt 'Age variation of formation stages for ten permanent teeth' *J dent Rec* **42** (1963) 1490-1502.

Older										
Tooth	1	2	3	4	5	6	7	Score	Age	Range
Stage	H	H	H	H	G	H	F			
Score	11.8	13.7	11.9	13.5	13.2	19.3	13.2	96.9	14.3	12.8-16.2
Younger										
Tooth	1	2	3	4	5	6	7	Score	Age	Range
Stage	H	H	F	F	D	H	D			
Score	11.8	13.7	10.0	12.3	9.7	19.3	10.1	86.9	9.5	8.5-10.7
Anne Mowbray										
Tooth	1	2	3	4	5	6	7	Score	Age	Range
Stage	H	G	F	E	D	G	D			
Score	12.9	12.2	10.3	11.8	10.6	14.0	11.1	82.9	8.4	7.7-9.2
Older										
Tooth	1	2	3	4	5	6	7	8	Age	Range
Stage	Ac	Ac	Ac	Ac	A½	Ac	A½	Crc		
Age	8.0+	9.3+	13+	13.5+	12.7	9.0+	10.0+	10.6	11.6	10.6-12.7
Younger										
Tooth	1	2	3	4	5	6	7		Age	Range
Stage	Ac	Ac	R⅔	R½	Crc	Ac	Crc			
Age	8.0+	9.3+	8.0	8.5	6.2	9.0	6.3		7.8	6.3-9.3
Anne Mowbray										
Tooth	1	2	3	4	5	6	7		Age	Range
Stage	Ac	A½	R½	R¼	R¾	A½	Crc	Crc		
Age	7.7+	8.1+	7.0	6.5	6.6	7.0	6.1		7.1	6.1-8.1

Table 1: dental age determined by the methods of Demirjian *et al* (upper) and Moorrees *et al* (lower).

Older	length (mm)	age in years according to: Maresh	Sundick	Stloukal et al	graph
femur	383	12	14	over 14	14+
tibia	306	12	13-14	14+	14+
humerus	242	10.5	13-14	13-14+	13-14+
ulna	195	10	12	12-14	12-14
probable age		13½-14½*	12-14	12-14	12-14
Younger					
femur	345	10	13-14	13-14	13-14+
tibia	274	9.5	13-14	13-14	13-14+
humerus	222	8.5	11-14	11-14	11-14
ulna	182	8	10	10-12	10-13
probable age		11½-12½*	10-14	10-14	10-14
Anne Mowbray (data fide Rosemary Powers)					
femur	278	6.5	9-10	8-11	8-12
tibia	220	6.5	8-10	8-12	8-13
humerus	187.5	6	8-9	7-10	7-11
ulna	148	5.5	8	6-8	6-9
probable age		9*	8-10	6-12	6-13

*corrected by a factor of 2½-3½ years (see p. 261).

Table 2: estimates of skeletal age from long bone lengths

chronological age between 8.6 and 10.7 years. For the older child to have been 12.9 years at death he would have been quite precocious dentally. Precocious dental development is unlikely in individuals with hypodontia, which predisposes to delay in development of the teeth[9]. It is possible for the older child to have been 15 years and seven or eight months at death. He would have been below the average for his age, but this retardation might be expected in an individual with hypodontia.

Another, more traditional, method of dental age assessment also relies on the evaluation of the developmental stage of each tooth as seen in radiographs[10]. By this method the older child was between 10.6 and 12.7 years, the younger 6.3 and 9.3 years and Anne Mowbray was between 6.1 and 8.1 years. This method would appear to underage in this case (Table 1).

It is important that the appropriate ageing charts are selected. Although dental development is probably the part of a child's growth least affected by environment or race, there is variation between different groups. By applying the data from Anne Mowbray, whose age at death is known, it is possible to gauge the reliability of various methods of estimating the age of a juvenile from bone length. Anne is undersized for her age by 2½ to 3½ years by today's standards[11]. This we find is fairly typical of children of the past, whether boys or girls. Her age assessed by reference to the data of Sundick[12] or Stloukal and Hanakova[13] agrees more closely with her known age. I am indebted to my colleague Miss Rosemary Powers for permission to use the measurements that she made of Anne Mowbray's bones the day before she was reburied in 1965 (Table 2).

Using the argument that children of the past were 2½ to 3½ years behind in their skeletal growth, then the smaller skeleton would be that of a child of 11½ to 12½ years and the larger of a child of 13½ to 14½ years.

Two points emerge from a study of the relative lengths of the bones. The individual bone lengths are compatible with bones from two discrete skeletons. There is no evidence for a random assortment of bones, nor for the skeletons having been made up in 1678 to replace parts removed before reburial, as has been suggested[14].

The other point is that all three children had rather short forearms. This is more likely to be typical of the English population as a whole at this time rather than evidence of consanguinity.

Once an allowance has been made for the small stature of children in the past, we see a good agreement between the dental age and the skeletal age of the older child. The agreement is not good for the younger child. Either he was tall for his age or dentally retarded. The former seems more likely. If at a dental age of 9.6 years he had the femur length of a twelve year old of the day, he would have been

11. M. M. Maresh 'Linear growth of long bones of extremities from infancy through adolescence' *Amer J Dis Children* **89** (1955) 725-42.
12. R. I. Sundick 'Human skeletal growth and age determination' *Homo* **29** (1978) 228-49.
13. M. Stloukal and H. Hanakova 'Die Lange der Langsknocken alt slawischer Bevolkerungen – unter besonderer Berucksichtigung von Wachstumfragen' *Homo* **29** (1978) 53-69.
14. G. White (ed.) 'Appendix J. The Princes in the Tower' *The Complete Peerage* Vol. 12, part 2, 32-9.

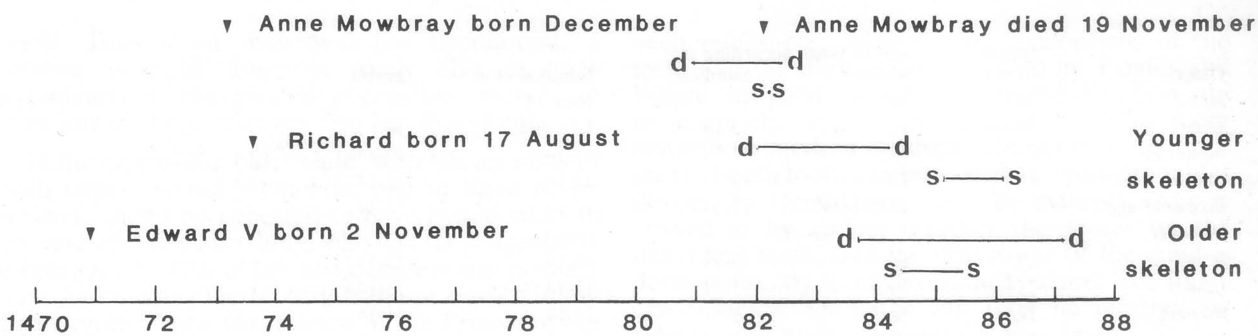

Fig. 4: correspondence between dental and skeletal age for Anne Mowbray and the skeletons from the Tower.
d – d = dental age; s – s = skeletal age.

tall for his age. Such children grow up to be tall and usually have a tall parent.

Skeletal maturity

Apart from size, the developmental state of the bones and joints of the skeleton can be useful guides to skeletal maturity in much the same way as are the teeth.

Tanner and Wright noted four markers of skeletal maturity:

(a) the odontoid process of the axis or second cervical vertebra is not ossified. The axis process normally ossifies about the twelfth year, but very rarely it may persist, unossified into adulthood[15].

(b) the laminae of the sacrum are ½ inch apart. Gray's Anatomy[16] states for the sacrum, that the costal or lateral element unites with its half of the vertebral arch or lamina between the second and fifth years. This element unites ventrally with the centrum and dorsally with the opposite about the eighth year. If this is so, and Gray states that the information is based on few specimens, then the bone attributed to the older skeleton is markedly underdeveloped.

There is, however, another interpretation. In a percentage of cases, a considerable part of the dorsal wall of the sacral canal may be wanting, as consequence of the imperfect development of the laminae and spines. This is partial spina bifida occulta. Bifid first sacral vertebrae occurred with a frequency of 10.9% in males and 5.6% of females in the medieval population from Winchester. It seems probable that the incomplete sacral vertebra described by Tanner and Wright was in fact cleft. It would not therefore help in assessing the age of the individual.

(c) the epiphyses of the shoulder and hip are unfused. When the hip starts to ossify, secondary centres appear about puberty and join the rest of the bones between the 15th and 25th years. Ossification of the shoulder takes place at or soon after puberty – about the 14th year in the female and about the 17th year in the male. From this it can be inferred that the skeletons are of adolescents who have not attained puberty.

(d) the epiphyses of the long bones are unfused. Although there is considerable variation in the age at which epiphyses fuse, it normally occurs after puberty. The unfused state of the long bones indicates that the skeletons are those of juveniles.

Conclusion

We can ask what are the chances of finding two skeletons of adolescents with similar wormian bones and hypodontia. Add the possibility that they are male and one is tall.

I have suggested that the discrepancy between the dental age and skeletal age of the younger skeleton from the Tower might be because the child was tall for his age. A tall child is more likely to have a tall parent or uncle than a short. When the coffin of Edward IV (the father of the Princes in the Tower) was opened in 1789, "the skeleton measured six feet three inches and a half."[17]. Elsewhere, the Plantagenets are referred to as being tall. However, Richard III (brother to Edward IV) and his father Richard, Duke of York, were reputed to have been small and hard featured.

If the evidence for consanguinity can be accepted, and the skeletons described by Tanner and Wright are indeed those of Edward V and his brother, Richard Duke of York, younger by two years nine months, and one wishes to propose that they died or were killed at the same time, the most likely period that is compatible with the dental and skeletal age for both skeletons would be some time in the year 1484 (Fig. 4).

15. W. Bailey 'Persistent Vertebral process epiphyses' *Amer J Roentgenol Rad Therapy* **42** (1939) 85-90.
16. R. Warwick and P. L. Williams *Gray's Anatomy* (35th edition) (1973) 246.
17. Emlyn 'The vault, body and monument of Edward IV in St. Georges Chapel at Windsor' *Vetusta Monumenta* 3 (1799) 1.