In Search of Robert Bruce, Part I:

Craniofacial Analysis of the Skull excavated at Dunfermline in 1819

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Key words

Robert Bruce; leprosy; skeletal, anthropology; craniofacial

Abstract

Robert Bruce, king of Scots, is a significant figure in Scottish history, and his facial appearance will have been key to his status, power and resilience as a leader. This paper is the first in a series that discusses the burial and skeletal remains excavated at Dunfermline in 1819. Parts II and III discuss the evidence relating to whether or not the burial vault and skeleton belong to Robert Bruce, and Part I analyses and interprets the historical records and skeletal structure in order to produce a depiction of the facial appearance of Robert Bruce.

Introduction

'Robert Bruce, the ruler of a small kingdom, is one of the big figures of history' (Barrow, 1965: xix). Barrow's classic book is the starting point for modern study of Bruce and the benchmark for subsequent biographies (McNamee, 2006; Penman, 2014). While other historians have been less consistently generous than Barrow in their estimation of Bruce as man and king (Duncan, 1966; Nicholson, 1974; Tanner, 2004), none would dispute his claim to greatness.

Does this icon have a face? Bruce's first biographer was John Barbour, but nowhere in Barbour's 13,000 lines, or in any other contemporary or near-contemporary text, do we find any clue as to what Bruce looked like, and the images on the coinage and the two extant great seals of his reign are too derivative and formulaic to be of genuine service in this regard. In addition, the first-hand testimony of the papal legates who came to Scotland in 1317 (Rymer, 1727-9: vol. 2, 340-1) remains a verbal portrait of character alone.

All modern attempts to recreate the face of Robert Bruce trace their origin to 17 February 1818, when workmen uncovered a burial vault within Dunfermline Abbey ([Jardine], 1821: 28). On 5 November 1819, the skeleton within was exhumed and removed from two sheets of lead. The skeleton was examined; at least one cast of the skull was made in plaster of Paris; the public was allowed to file past and pay its respects while the skeleton lay exposed; the remains were immediately reburied where they had been found, in a reconstructed vault in a lead coffin filled with melted pitch, and an official report was published ([Jardine], 1821: 31-43; Coleman, 2014: 46-7).

Was this the burial vault and skeleton of Robert Bruce? Between 1819 and the present no scholarly consensus on the question has been reached. In the official report Bruce was imposed upon the evidence rather than the evidence being allowed to speak for itself, resulting in a series of 'proofs' based upon unreasonable conjecture, spurious science and outright falsification. ‘In Search of Robert Bruce, Part II’ (MacGregor and Wilkinson, 2019) discusses these ‘proofs’ before reviewing the evidence afresh. ‘In Search of Robert Bruce, Part III’ (MacGregor and Wilkinson, forthcoming), discusses the issue of tomb location. The conclusion supports that of Bryce in 1926: ‘there is a probability, even a strong probability, but not a certainty that the tomb discovered in 1818 was actually that of King Robert Bruce’ (Bryce, 1926: 91). The fuller evidence available for Bruce allows him alone to be tested against all relevant benchmarks, which individually and collectively give no grounds for ruling him out, although they do not put the matter beyond reasonable doubt. In the present paper, all references to ‘Robert Bruce’ need to be interpreted with these comments and caveats in mind.

Physically, psychologically and socially, the face is hard to ignore, and its significance in self-attainment and social communication cannot be overestimated. The face symbolises identity and indicates gender, sex, age, ancestry, health, mood, emotion, and sometimes even character and personality (Synnott, 1989), depending on how the face is presented to the world. The centrality of the human face as symbolic of personality permeates the fabric of human experience. Indeed Schopenhauer (1851: 250, 254) wrote: ‘That the outer man is a picture of the inner, and the face an expression and revelation of the whole character, is a presumption likely enough in itself, and therefore a safe one to go by’. It is not surprising then, that we desire to see the faces of historical figures and idols from the past and make judgements on their personality, attractiveness and character. Siegel (1999) states that the face has the power to cause reference beyond itself and yet to be the central site of signification and, as Rumsey agrees (2004), our faces help us understand who we are and where we come from, whilst wrinkles and marks serve as reminders of each individual life history.

It is well-established that the face is key to the perception of attractiveness and this has a measurable effect on self-esteem and life opportunities. Cognitive bias towards attractive people is a recognized human response (Bar-Tal and Saxe, 1976; Kaczorowski, 1989; Wuensch et al., 1991; Berry, 1991; MacLin and MacLin, 2004; Rhodes et al., 2005; Boo et al., 2013), with attractiveness related to higher social status (Anderson et al., 2001). In addition, we make rapid, unreflective judgments on competence (Todorov et al., 2005), aggression (Carré and McCormick, 2008) and leadership qualities (Rule and Ambady, 2008) based on facial appearance. Therefore, the facial appearance of a king, perhaps more than for any other person, may be crucial to his power, status, resilience and reputation.

This research analyses the skull excavated at Dunfermline in 1819 and presents two new depictions of Robert Bruce's facial appearance, primarily based on skeletal morphology and osteological interpretation, but also considering the historical context relating to his status and reputation to inform this interpretation. This is not the first time that the face of a king has been depicted from skeletal analysis, and previous examples have contributed to the changing views of academia and the public in relation to historical figures, such as Richard III (Wilkinson, 2013; Pappas, 2013), Henri IV (Samuel, 2013), Nefertiti (Friend, 2003) and Tutankhamun (Handwerk, 2005).

Materials and Methods

The first recorded assessment of the skull from Dunfermline Abbey was carried out in 1819 by Professor Munro (Professor of Anatomy in Edinburgh), Professor Gregory (His Majesty's First Physician for Scotland), and Sir Henry Jardine (the King's Remembrancer). The Jardine (1821) report described the skull as 'in a most perfect state' and records that the skull was further assessed by Robert Liston, a surgeon from Edinburgh and cast in plaster by an artist called Mr Scoular[1]. The related skull casts have also been assessed a number of times, and some points of interpretation remain controversial. The anatomist, Karl Pearson (1924) assessed the skull cast from the Anatomical Department of the University of Edinburgh, shortly followed by another assessment carried out on the cast from the Hunterian Museum by Professor Thomas Bryce in 1926. It then was not until 1958 that the skull cast was examined again by Brothwell to ascertain whether or not Bruce suffered from leprosy, and this was revisited by Moller-Christensen and Inkster (1965) a few years later. Macleod and Hill (2001) re-examined the skull in 1998, finally followed by Kaufman and MacLennan in 2001.

There is no doubt that the skull is an adult male of Caucasoid-type ancestry, and on this all previous assessments (including the earliest utilising the whole skeleton) are in agreement. The teeth demonstrate flattened occlusal surfaces where the maxillary and mandibular teeth have ground against one another, creating a matching pattern of wear. Since wear of this nature occurs over time, this is inconsistent with a young adult (20 to 35 years). In addition, the relatively good dental condition, with only two missing maxillary molars and a full set of mandibular teeth, suggests an adult who is not elderly (>70 years), in which case extensive tooth loss would be expected. Therefore, this suggests a man of middle age, with a possible range from 40 to 65 years (Brothwell, 1963; Lovejoy et al., 1985). A more reliable age estimation is not possible from assessment of a skull cast, but the early skeletal assessment of the original remains (Jardine, 1821) does not suggest youth or senescence.

There are two controversial interpretations concerning the Bruce skull; signs of leprosy and healed wounds on the skull. For at least the last two years of his life, Robert

[1] The Perthshire Courier on 18 November 1819 refers to the skull being ‘properly cleaned, and two excellent casts taken from it’. Jardine’s reference to the presence on site of ‘Mr Scoular’, the artist or sculptor who ‘proceeded to make a cast’ ([Jardine], 1821: 36), is corroborated by the eyewitness account set out in a letter of 1 March 1820 ([‘G’], 1820: 142).

Bruce suffered from a fluctuating condition, which at its worst left him reliant on others to move him by litter,[2] and scarcely able to move 'anything but his tongue' (Barrow, 1988: 323). Contemporary or near-contemporary non-Scottish chroniclers refer to the king and his condition as 'leprosus' (Stevenson, 1839: 264); 'lepra percussus' (Hamilton, 1849: 301); 'le Roy Robert, qui mort estoit de lepre' (King, 2005: 106-7) and 'la grosse maladie' (Polain, 1863: 33, 48, 79). These terms, especially Latin 'lepra', were used in medieval sources of a disease then widespread in Europe, before declining in the later middle ages (Demaitre, 2007: 82, 85-8; Rawcliffe, 2006: 346, 348-9). In Scotland, it was found on the mainland into the seventeenth century, and later still in Shetland as in other parts of far northern Europe (Simpson, 1841-2; Brown, 1893; Clay, 1909; Stearns, 1944; Durkan 1962; McNeill and Nicholson 1975; Cowan and Easson 1976; Richards 1977). In his final years Bruce is known to have been attended by leading medical practitioners (Proctor, 2007) and had Bruce suffered from 'lepra', there can be little doubt that his doctors would have been capable of diagnosing it, given their calibre and the state of contemporary medical understanding of the disease.

Would the non-Scottish chroniclers have had access to educated as opposed to popular opinion about Bruce's condition and would they have reported their information in good faith? These questions are discussed in length in Part I of this series (MacGregor and Wilkinson, 2019). The main conclusion drawn from the review of the historical evidence there is that no substantive grounds exist for disregarding the witness of those sources that advance 'lepra' as the primary cause of Robert Bruce's death.

[2] Both Barbour and the late-fourteenth century Scottish historian, John of Fordun, state that Bruce was carried by litter (Latin *grabatus*) when struck down by illness in the winter of 1306-7 (Duncan, 1997: 322-3; Skene, 1871: 343-4). The same must have been true towards the end of his life, for example in Ulster in 1327 and on his pilgrimage to Whithorn at Easter 1329, when he was clearly incapable of independent movement.

The reports on the state of the original skull and the cast all suggest loss of maxillary incisors and related alveolar bone loss, along with deterioration of the nasal bones. However, Pearson (1924) states that both the Jardine and Liston reports do not mention signs of leprosy, but do both offer trauma as the cause of the loss of maxillary teeth and alveolar bone. Pearson goes further and suggests a battle-axe or spear as the cause of the trauma in combination with signs of syphilis rather than leprosy. However, Bryce (1926) saw no signs of the pitted bone surface associated with syphilis and further discounted leprosy as ‘no mention of a diseased condition of the bones of the fingers or toes is to be found in the several accounts of the skeleton given by … the chief persons present at the disentombment’. However, a number of experts in osteoarchaeology disagree with this interpretation. Brothwell (1958) thinks that the nasal resorption and maxillary bone changes are typical of leprosy and states that ‘this leaves no doubt in my mind that this is also another example of cranial changes through leprosy’. Moller-Christensen and Inkster (1965), authorities on the osteological appearance of leprosy in medieval skulls, agree with Brothwell and show multiple examples of skulls with leprosy exhibiting similar features. In addition, Macleod (1998) states that ‘A peculiar erosion around this region (the upper front teeth), and additional blunting of the bone margins around the nose, are features all highly suggestive of leprosy’. However, leprosy cannot be confirmed without direct skeletal assessment and since this is not possible, the decision was made to depict Robert Bruce as two versions, one without leprosy and one with leprosy.

Macleod (1998) states that if Bruce did suffer from leprosy the condition may not have been particularly noticeable in the weather-beaten face of a warrior king. Simpson (1841-2, Part II: 2-4) describes the medieval symptoms of leprosy as a gradual process of deformity announced and preceded by patches of skin discolouration of ‘a tawny red hue’. Khanolkar (1959) describes the resulting destruction of the hair follicles, sweat glands and sebaceous glands and states that the enhanced vascularity would lead to reddening of the skin, but not necessarily any other deformations. Therefore, the skin appearance of leprosy can vary from mild redness, bumps and inflamed skin, to a severe leonine face with creases and multiple lumps. A mild demonstration of leprosy can look no more unusual than a deeply weathered face, which cannot have been unusual in medieval Scotland, and may well have applied to Robert Bruce irrespective of whether he suffered from leprosy or not, given the degree of exposure to the elements he must have experienced during his lifetime.

Nasal depression is a well-documented facial symptom of leprosy (Antia, 1962) varying from minor cartilaginous bridge line depression to total absorption of the bony and cartilaginous framework due to exposure necrosis. Moller-Christensen (1953) emphasised the loss of the bony nasal spur of the maxilla as one of the important evidences of leprosy. The loss of the edge of the bony aperture and nasal spine on the skull of Robert Bruce is certainly consistent with leprosy and would suggest a nasal depression. However, the nasal bridge is still intact and high, suggesting a bridge line depression rather than a total absorption of the nasal framework. A midly leprotic nasal appearance might have been mistaken for battle trauma by those who met Robert Bruce. It is worth noting that the loss of the edge of the bony aperture could also be due to postmortem deterioration.

Another facial characteristic of leprosy is the loss of eyebrow hair caused by damage to the hair follicles with resulting alopecia. In addition, ear deformities are common with elongated lobes and an irregular moth-eaten helix. There are some other less common facial characteristics of leprosy, including lagophthalmos and sagging facial skin, but none of these symptoms can be determined from skeletal assessment. Antia (1962) described the occurrence of facial deformities as 39% deformed ears, 36% loss of eyebrow hair, 26% nasal depression, 9% sagging facial skin and 6% lagophthalmos. Since the skull demonstrates some skeletal deformation relating to nasal depression, we can justify the inclusion of the other more frequently recorded characteristics, namely loss of eyebrow hair and ear deformity. However, the other less common facial deformities are not included in the facial depiction of Robert Bruce.

Therefore, if Robert Bruce had leprosy, then, based on the skeletal and historical evidence, his most likely facial appearance would have been a red patchy face, depressed nose, deformed ears and sparse eyebrows. These facial characteristics may not have been significant enough to change the perception of his appearance, or affect his visual status as a powerful and influential king.

The other area of contention in relation to the skull of Robert Bruce is whether or not there are signs of healed wounds to the face. Liston was the first assessor to mention healed trauma (Jardine, 1821) and he noted 'a kind of mark on the right side of the sagittal suture'. However, neither Pearson (1924) nor Bryce (1926) mention any healed trauma, and Bryce suggests that 'any marks or defects are clearly due to imperfections in the casting'. Analysis of the skull cast shows no signs of a healed wound in this area. However, Liston frequently confused the right and the left in this assessment, and it is possible that he meant the left side of the sagittal suture where a line is visible. The facial reconstruction by Neave (Macleod and Hill, 2001) also shows a healed wound in this area originating from the supraorbital margin consistent with a sharp force injury, and Macleod and Hill (2001) describe this as 'uncomplicated' healing with a soft tissue scar. On inspection, there does appear to be a difference in shape between the left and right supraorbital margin, but this is minor and surrounds a clearly defined left supraorbital notch. Whilst a supraorbital notch is not visible at the right supraorbital margin, it is common to see asymmetry in the supraorbital region. It is possible that this area on the skull demonstrates a healed wound, but this is also a common site for vascular paths, especially on robust male skulls, and this seems a more likely feature without confirmation of bone healing.

The next mention of healed trauma is from Macleod and Hill (2001) who note that the left orbit is markedly larger than the right, the distal portion of the superior orbital margin deflected outward, damage to the lower orbital rim and an outward and backward deflection of the left zygoma, all indicating a tripod-type fracture. This is attributed to blunt force injury without soft tissue scarring. No other report mentions this healed injury, even those by individuals who assessed the actual skull (where healed bone would have been apparent). Kaufman and MacLennan (2001) state that the left zygomatic arch was missing and Pearson (1924) remarked that the cast lacked the left zygomatic ridge, but he did not know whether this was broken off in the skull or more recently from the cast. Kaufman and MacLennan (2001) however, suggest that the edges of the bone showed signs of healing. However, this is a different area to that described by Macleod and Hill, and Kaufman and MacLennan do not mention the zygoma and orbit. Macleod and Hill (2001) do not mention the missing zygomatic arch at all. There seems to be a good deal of confusion surrounding the left side of the skull at the cheek and orbit. It is unclear whether or not the left superior-lateral corner of the orbit was missing on the original skull, as some photographs of the cast appear to show the orbital bone and others do not. The Hunterian cast, and the plates of the cast from the Anatomical Department of the University of Edinburgh in the Pearson report (1924), show the missing orbital bone and the missing zygomatic bone. Signs of healed bone are extremely difficult to identify from a skull cast, and it is unclear from the two papers (Macleod and Hill, 2001; Kaufman and MacLennan, 2001) what features have been associated with healing bone. A fractured zygomatic arch is a frequent facial injury due to its prominence and vulnerability (Haung et al., 1990), and this is often recorded as a postmortem fracture. It is also common to see asymmetry in orbital size and zygoma shape (Vig et al., 1975; Peck et al., 1991). Therefore, in conclusion, the left zygomatic bone and orbit do not appear unusually different to the right, and if there has been blunt force trauma the bone healing is not visible. However, since this type of trauma would not have affected the soft tissues, any facial depiction will correctly reflect the position of the zygomatic complex and orbit regardless of whether or not there has been a blunt force injury. Therefore, no soft tissue changes associated with healed trauma were included in the facial depictions.

In the absence of DNA evidence, and given the minimal historical evidence relating to his ancestors and descendants, interpretation of the hair, skin and eye colours of Robert Bruce was carried out largely on the basis of genetic probabilities. The inheritance patterns of such traits are now reasonably well understood and comparatively simple (Mengel-From et al., 2009), but in the absence of an actual DNA sample from the remains we cannot infer directly any genetic information regarding Robert Bruce. Nonetheless, given contemporary descriptions and portraits of some of Bruce's relatives, we considered whether it might be possible to predict his probable eye and hair colour. Blue eye colour is strongly associated with recessive variants in the *OCA2* gene, and is thought to have arisen relatively recently in human evolution, well after the migration out of Africa (Eiberg et al., 2008). Indeed, the blue eye *OCA2* variants are relatively common in northern Europe. Nonetheless, blue eyes (~38%) remain less frequent than brown eyes (44%) in the Scottish population (Mengel-From et al., 2009). Coupled with evidence from portraits – although most of these are not contemporary – showing brown eye colour in James I and his descendants (Scottish National Portrait Gallery: https://www.nationalgalleries.org), these data suggest that on the balance of probabilities, Robert Bruce had brown eyes.

The ancestral hair colour in humans, and that most frequent in the majority of populations, is brown or black. In northern Europe red hair is relatively common, with an incidence of ~15% in the Scottish population (Mengel-From et al., 2009). Red colour is primarily mediated by recessive variants in the melanocortin 1 receptor gene (*MC1R*). These variants are recessive and red-haired individuals need to inherit two copies of the red hair colour genetic variant, one from each parent. These variants are present at a combined frequency of ~44% in the Scottish population (Mengel-From et al., 2009). Thus, the proportion of individuals inheriting two copies of these variants is expected to be 19.36% (0.44 * 0.44). This is slightly higher than the observed frequency of red hair (~15%) and reflects the complex genetics of hair colour and the action of genetic variants in other genes that can mask the effects of the *MC1R* variants (Mengel-From et al., 2009). Nonetheless, we can use the frequency of these *MC1R* variants, assuming they have not changed significantly over the last 700 to 800 years or so, to roughly estimate the likelihood that Bruce had red hair.

The copy of the Scottish royal genealogy in the ‘Poppleton MS’ suggests that one of Bruce’s great great granduncles, William I, had red hair (Broun, 1999: 176). We can therefore assume that William I must have inherited two copies of the red hair *MC1R* variant, one from each parent. Thus, we can assume that William I’s father (one of Bruce’s great great great grandfathers), Earl Henry, carried at least one copy of the *MC1R* genetic variant associated with red hair. Likewise, William I’s mother must also have carried at least one copy of the *MC1R* genetic variant associated with red hair. There is a 50% probability that William I’s brother David earl of Huntingdon would have inherited the same version of the *MC1R* gene from his father, and a 50% probability that this same copy would have been transmitted to David earl of Huntingdon’s daughter, Isabel. The same would be true for Isabel inheriting the same version of the *MC1R* gene carried by William I from his mother through David earl of Huntingdon. This yields a combined probability of Isabel inheriting one of the same red-hair associated versions of *MC1R* of 50% (0.5 * 0.5 + 0.5 * 0.5). The overall chance that Isabel would have passed this same version of the gene identical by descent to her son Robert Bruce the Competitor would be 25% (0.5 * 0.5), and likewise that he would pass that to his son, and Bruce’s father, Robert Bruce earl of Carrick would be

12.5% (0.25 * 0.5). Therefore, the chance that this same version of the gene identical by descent would pass all the way to Robert Bruce king of Scots would be halved again to 6.25% (0125 * 0.5). This is a relatively low probability and only marginally increases the likelihood that Robert Bruce would have had red hair from the expected population average of 19.36%, to 20.9% (0.0625 * 0.44 + 0.9375 * 0.44 * 0.44).

However, pictorial evidence suggests that Robert's great great grandson James I may also have had red hair (Scottish National Portrait Gallery: https://www.nationalgalleries.org). This would imply that James I's father, Robert III, carried at least one copy of the *MC1R* red hair associated variant, and a 50% probability that Robert III inherited it from his father Robert II. Likewise, there is a 50% probability that this same version of the *MC1R* gene was inherited from Robert II's mother Marjorie Bruce, and a 50% chance that she in turn inherited it directly from her father Robert Bruce. Overall, the likelihood that a red hair associated version of the *MC1R* gene was inherited by James I, identical by descent from Bruce, is therefore 12.5% (0.5 * 0.5 * 0.5). The chance that one of the red hair versions of the *MC1R* gene carried by William I was carried all the way through Bruce and onto James I is only 0.39%. Nonetheless, knowing that both William I and James I may have carried two copies of the red hair associated version of the *MC1R* gene does increase Bruce's chance of having red hair from the population average of 19.36% to 24.1% (see Figure 1). However, this figure is still well below 50% and in the absence of additional information, the balance of probabilities remains that Bruce did not have red hair and that he thus was more likely to have had brown hair.

Figure 1: Conditional probabilities of red hair in Robert Bruce and his relatives

Males = squares, females = circles, red hair = red, unknown hair colour = grey. Conditional probabilities (%) of red hair calculated from 100M simulations, assuming 50% transmission for each variant from parents, and 44% red hair frequency associated *MC1R* variant in general population.

There have been a number of previous attempts to reconstruct the face of Robert Bruce. Pearson (1924) was the first to suggest that 'a great sculptor could from it restore the personality of Bruce to the Scottish nation and provide an ideal far more correct than the fancy portraits of the 17th and 18th centuries'. In 1958, the earliest facial reconstruction of Robert Bruce was produced by the Edinburgh sculptor, Charles Pilkington-Jackson, in collaboration with Professor Romanes, Professor of Anatomy at the University of Edinburgh, and this was exhibited at the Royal Scottish Academy. In 1996 Dr Iain Macleod, a dental radiologist, commissioned three reconstructions of Robert Bruce using different techniques from Professor Peter Vanezis (University of Glasgow), Brian Hill (Newcastle Dental Hospital) and Richard Neave (University of Manchester). The faces from all four reconstructions were then compared with each other using 3D scans and found to be consistent (Macleod, 1998; Macleod and Hill, 2001), despite numerous apparent differences.

The first steps in our reconstruction were to 3D scan the skull cast using a Polhemus FastSCAN 3D laser scanner, and then import the 3D model into 3D System's Touch X © hardware and Geomagic Freeform Modelling Plus © software. The craniofacial reconstruction system utilises a database of pre-modelled muscles and anatomical structures created for use in forensic depiction, and the determination of facial features is carried out by assessing related bony detail, employing a number of standards related to anatomical principles at each feature (Wilkinson and Rynn, 2012; Rynn et al., 2010; Wilkinson, 2010; Wilkinson and Mautner, 2003; Fedosyutkin and Nainys, 1993; Angel, 1978; Gerasimov, 1955; Whitnall, 1912) and the width of the philtrum (Rynn et al., 2010; Wilkinson et al., 2003; Denis and Speidel, 1987; Talass et al., 1987; Holdaway, 1983; Koch et al., 1979; Roos, 1977; Rudee, 1964; Waldman, 1982; Subtelny, 1959; Gerasimov, 1955). This system has been tested using the skulls of living subjects (Lee et al., 2012; Wilkinson et al., 2006) and these studies suggest that it is possible to create a face that is recognisable, with approximately 67% of the surface of the face showing less than 2 mm of error. High quality photographs of the skull from the Pearson report (1924) were also utilised.

The eyes of Robert Bruce demonstrate horizontal eye fissures, normal eyeball protrusion and low straight eyebrows. Many of the nasal details are not easy to determine from the skull cast due to the deterioration of the nasal aperture borders, alveolar processes and nasal spine. However, some details and measurements could be ascertained and the nose of Robert Bruce is depicted as large, with a straight dorsal ridge, a rounded nasal tip, horizontal columella and wide philtrum. The nose is the least accurate feature of this facial depiction due to the bone deterioration. The skull of Robert Bruce demonstrates the presence of clear nasolabial creases. The lips of Robert Bruce are depicted as moderately thin with up-turned corners, a square lower lip, a wide philtrum and a slightly more prominent lower lip than upper lip. The skull also suggests a prominent chin and square jaw line. The skull demonstrated large, prominent, lobed ears and Robert Bruce has a thick muscular neck.

The next stage of the facial reconstruction process (Wilkinson et al., 2006) is the addition of a skin layer over the muscle structure to fill the face to the level of the tissue depth pegs and here we assume that Robert Bruce had an average amount of fat over the surface of the face. In this case, the minimum tissue depth measurements for White European males of 50 to 59 years (Helmer, 1984) were used as more representative of a fourteenth century population (i.e. without contemporary levels of obesity[3]). This skin layer follows the shape of the muscles below, so that the main determinant of facial morphology remains as anatomical structure.

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[3] The World Health Organization (WHO) states that worldwide obesity has tripled since 1975. In 2016, 39% of adults, 18 years and older, were overweight and 13% were obese. http://www.who.int/en/news-room/fact-sheets/detail/obesity-and-overweight

Producing an accurate depiction of facial morphology is the most important objective of craniofacial reconstruction from skeletal remains, but in order to generate a life-like appearance, additional texturing (applying colour and pigmentation) is required (Claes et al., 2010). Subtle alterations to the skin layer in texture and colour, based on age, sex and ethnicity, enhance the individuality of the generated facial form (Evenhouse et al., 1992). The process of texturing the skin of this depiction of Robert Bruce included export of the 3D model from Geomagic Freeform Modelling Plus © into Pixologic ZBrush 4R7 © where texturing methods, including draping digital photographs over a solid 3D object or hand painting directly on to the 3D model surface, were utilised (Mahoney and Wilkinson, 2010). Three-dimensional technologies used in gaming and film industries allow the production of realistically textured CGI, creating familiar images consistent with photographs or film sequences (Wilkinson 2005; Davy et al., 2005). Pixologic ZBrush 4R7 © is an industry standard software used in the visual effects and gaming industries to generate and texture 3D models including digital human characters.[4]

The Pixologic ZBrush 4R7 © process includes topology[5] 'cleaning', UV map[6] creation, basic eye shape addition (Davy et al., 2005), skin detail sculpture to represent

[4] Computer-generated characters developed in Pixologic ZBrush 4R7 © by American first-party video game developer Naughty Dog for the PS4 game 'UNCHARTED 4: A Thief's End' are examples of such work. Naughty Dog's Zbrush workflow was presented at ZBrush Summit 2016: https://www.youtube.com/watch?v=aHmWZey9r9g

[5] Topology refers to the basic structure of a 3D mesh, i.e. the 3D coordinates of the mesh vertices (Karini and Gotsman, 2000).

[6] A 3D model must always contain both 3D shape and texture information. Accurate 3D texture information can be retained in a 2D image format by using the so-called *UV* map. The axes of the 2D *UV* map are called U and V. *UV mapping* is a process which can roughly be described as a coordinate mapping function that warps a 2D image containing texture information to a 3D mesh (Levine and Yu, 2009). In addition to the standard XYZ Cartesian coordinates, each vertex has a UVW coordinate vector, which corresponds to its texture as opposed to its position in virtual space (Davy et al., 2005).

ageing (Kingslien, 2011; Spencer, 2010), spotlighting, polypainting, skin shading, texture maps (Abate et al., 2004; Levine and Yu, 2009) and hair plug ins.

Ageing skin loses elasticity, wrinkles form and the facial lines become more obvious (Mullins, 2012). The most consistent change to ageing skin is in the overall texture from smooth to rough, with sagging of tissues, notably under the eyes and at the neck (Mullins, 2012). With increased age, eyebrows become coarser with longer hairs, the hairline recedes at the temples, and there is a gradual loss of hair pigmentation (Neave, 1998). Robert Bruce is therefore depicted with appropriate age-related changes to the skin, including crow's feet, eye bags, neck and forehead creases.

With regard to facial hair, the formulaic coins show a clean-shaven face with curling hair, closely resembling the coins of Bruce's immediate predecessors and successors. The great seal images, on the other hand, may suggest a short beard and curling hair (Pearson, 1924: Plates VII, XII; [Spink], 2002: 21; Birch, 1905: 39-43, 135, 139; Duncan, 1988: 178-85). Therefore, given the absence of better historical evidence and Bruce's middle age, short, mildly receding hair and slight facial stubble is presented on the leprosy-free depiction, to maximise visual access to the face. The decision to create depictions of Bruce wearing a bascinet and aventail allowed for the elimination of issues of hairstyle, leaving the emphasis in these depictions upon the face alone.

Decisions relating to Robert Bruce's likely headwear referred to John Barbour's epic poem *The Bruce*. This includes a passage describing a dramatic incident on the first day of the Battle of Bannockburn in 1314, when Bruce is charged by an impetuous English knight, Sir Henry de Bohun. Barbour tells us that 'on his bassynet he [Bruce] bar / Ane hat off quyrbolle ay-quhar, [always] / And thar-upon into taknyng [signifying] / Ane hey croune that he wes king'. The foolhardy knight recognised the king 'by the croune that wes set / [...] apon his bassynet' (Duncan, 1997: 449-51).

The bascinet - from the French for small basin - is an iron or steel helmet carefully shaped to protect the head, and they were a common sight on the medieval battlefield. Robert I's 1318 bilingual arming act in Latin and Scots stipulates that men with £10 worth of goods are to serve in the royal host armed in a 'bacinetum / basnet' (Innes and Thomson, 1814-75: i, 113; Caldwell, 1979: 8-11). However, no bascinets from the time of Bannockburn survive, and it is artwork such as manuscript miniatures and tomb effigies combined with later survivals that can provide information and inspiration. The shape of the bascinet changed throughout the fourteenth century from hemispherical to a more pointed peak, and the armourer who recorded an inventory of Richard, earl of Arundel's harness in 1397 made a distinction between the old round bascinets ('vailles rounde bacynetz') and those with high tops ('de haut tour') (National Archives, E 163/6/13). The neck defense attached by staples around the edge of the bascinet, through which a cord passes, is the mail aventail, constructed of steel rings riveted together to form a flexible mesh, and its name is derived from *vent*, the French for breath.

In Barbour's passage the bascinet has on it a hat of *cuir bouilli*, and this term means boiled leather in French. Its construction, however, more likely involved the soaking, shaping, and heat treatment of raw animal hide, as this tough material was used to make body defences. The 'hat' referred to by Barbour may have been some sort of covering. In 1322 the armourers of London complained that certain men were bringing old, worn out, and damaged bascinets into the city and re-covering them for sale ('veils bacenetz debruses and fauses ore nouelement couers'), to the 'vileyn esclaundre' or villainous slander of their craft (London Metropolitan Archives, Letter-Book E, fol. 133r). Softened leather, however, rather than *cuir bouilli* seems to have been the covering of choice. Edward II's armourer made payment for 'white buckskins to cover bascinets when the need arises' ('peux de Cheuerel blaunk por couerir bacinetz quaunt mestier soit') (National Archives, E 101/16/5). The hat worn by

Bruce in Barbour's passage may well have been decorative, while also serving as a mount for the crown. The leatherworkers of medieval Scotland produced beautiful and intricate goods as evidenced by examples from extensive excavations at Perth (Dransart et al., 2012: 379).

Whereas medieval armourers skilfully hammered out bascinets from one piece of metal, the 3D digital model of the bascinet was produced in pieces. A PolyMesh3D sphere in Pixologic ZBrush 4R7 ©, was manipulated to create a bascinet that fits closely to the underlying head shape, with additional details, such as the fleurs-de-lys and the leather straps.

To create the aventail, small pieces of mail were produced by manipulating a PolyMesh3D sphere in Pixologic ZBrush 4R7 ©, duplicating this new shape multiple times, and then repositioning each new shape using the transpose tools to create an interlocking latticework of shapes that represented a small piece of mail.

Many medieval kings and princes had crowns mounted on their bascinets. The blackened patina in the shape of fleur-de-lys shows where the crown would have sat on a royal bascinet dedicated to Chartres Cathedral now in the Musée des Beaux-Arts there (Cripps-Day, 1942: 91-95). It is believed to originate from Charles V, before 1380. A fine example of a depiction in sculpture is the tomb effigy of John of Eltham, earl of Cornwall, at Westminster Abbey. Earl John had campaigned in Scotland and his effigy was created shortly after his death in 1336. In both these cases the crown is closely shaped to the helmet, the leaves lying flat against the surface. This strongly suggests that the two were integral rather than independent and documentary evidence supports this (Berkeley Castle Archives, Muniment D1/1/30). The crown was produced in Pixologic ZBrush 4R7 © and images of Bruce's crown on his coinage and seals were projected on to the modelled crown in order to recreate exact details (Spencer, 2011).

These 3D models were exported from Pixologic ZBrush 4R7 © and imported into Autodesk Maya 2015 ©, into the existing 3D scene containing the Robert Bruce model with skin, eyes and hair.

For the 3D facial depiction of Robert Bruce with leprosy, the same process was repeated: 3D reconstruction in Geomagic Freeform Modelling Plus © > texturing in Pixologic ZBrush 4R7 ©> rendering in Autodesk Maya 2015 ©. In Pixologic ZBrush 4R7 ©, the skin colour textures that were painted on to the non-leprosy version of Robert Bruce were projected on to the 3D model with leprosy. This provides a similar base skin colour on both versions for consistency. Using reference images (Lepramuseet St. Jørgens Hospital archive, Bergen, and colour portraits of leprosy sufferers by Johan Ludvog Losting) and information gathered relating to the presentation of leprosy on the skin (Antia, 1962), additional skin details were sculpted and painted to produce the final version of Robert Bruce with leprosy. The 3D model with leprosy was exported and imported into the same 3D scene in Autodesk Maya 2015 © as the non-leprosy version of Robert Bruce containing the same eyes, hair and headgear.

Results

Figure 2: Facial reconstruction with visible muscle structure (left) and skin shape (right).
Face Lab team included Sarah Shrimpton, Mark Roughley and Caroline Wilkinson

Figure 3: Facial depictions of King Robert with leprosy (bottom) and without disease (top)
Face Lab team included Sarah Shrimpton, Mark Roughley and Caroline Wilkinson

Conclusions

The Robert Bruce depictions show a robust face with strong jaw line and thick neck. The final face can be compared to previous depictions from the skeletal remains of Robert Bruce. Two of the previous depictions appear significantly different; the Hill reconstruction has a less prominent nose, no nasolabial creases, a fuller face and longer upper lip. The Vanezis reconstruction has a longer face, smaller eyes, less prominent brow, shorter and more pointed nose, fuller cheeks and less clearly defined nasolabial creases. However, both these reconstructions have a similar chin and jawline. The other two reconstructions are similar to the latest depiction; the Pilkington-Jackson sculpture has the same cheeks, nose, eyes, chin and facial proportions, although the nasolabial creases are less marked and the upper lip is flatter. The Neave reconstruction is also similar, especially at the nose, brow, chin and cheeks, despite the portrayal of severe leonism and healed trauma.

Barrow opens his book's final chapter, 'In Search of Robert Bruce' (Barrow, 1988: 312-24), by acknowledging that 'it is easy to strip away the legend surrounding some notable figure from the distant past, but clearing away the legend does not necessarily reveal the man'. If this research has succeeded in revealing the face of Robert Bruce, in sickness and in health, then it is not for the historian to read the historical Bruce into the face, in the manner in which nineteenth-century phrenologists read him into the Dunfermline skull; but rather to reveal the man whose face this is, and what animated the physical form.

Acknowledgements

The authors would like to thank the reviewers, The Chancellor's Fund at the University of Glasgow for supporting the project, and all the team in Face Lab for the production of the facial depictions.

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