

## CORRESPONDENCE

# Ancient DNA of Emperor CAO Cao's granduncle matches those of his present descendants: a commentary on present Y chromosomes reveal the ancestry of Emperor CAO Cao of 1800 years ago

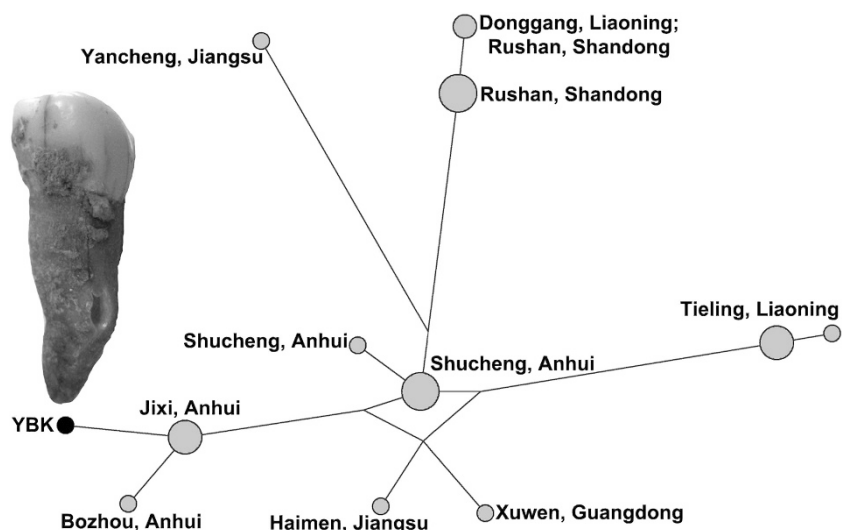
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In the 3rd issue, 57th volume of the *Journal of Human Genetics*,<sup>1</sup> we reported that the Y chromosomal haplogroup of the descendants of Emperor CAO Cao (O2\*-M268) is different from that of the Marquis CAO Can (O3-002611). Therefore, CAO Cao's claim of aristocratic ancestry from CAO Can, which has been doubted for almost 1800 years, is not supported by genetic evidence. However, the real ancestry of Emperor CAO Cao remains mysterious. Emperor CAO's foster grandfather, CAO Teng, was a eunuch. Historical documents suggest that Emperor CAO's father should have been adopted from CAO Teng's own clan,<sup>2</sup> while the Emperor's opponents alleged that Emperor CAO's father was adopted from beggardom. Here, ancient DNA extracted from a tooth excavated from Yuanbaokeng (YBK) Tomb I gives a clue to this mystery.

YBK I is a tomb of CAO clan located in Bozhou (Qiao Prefecture in Han dynasty), Anhui Province. CAO Cao was born in Bozhou and started his fortune there. Most of his relatives were buried in Bozhou. YBK I was suggested to be the tomb of CAO Cao's granduncle, CAO Ding.<sup>3</sup> We got one tooth of CAO Ding from the Museum of Bozhou. DNA was extracted from this tooth following the method described in our previous publication.<sup>4</sup> Our ancient DNA experimental operations are strictly controlled by following all the criteria for ancient DNA studies.<sup>5</sup> Twelve Y-STRs were successfully typed using Y-Filer kit (Applied Biosystems, Carlsbad, CA, USA). The 12 Y-STR values are as follows: DYS19: 15, DYS389I: 13, DYS389II: 30, DYS390: 23, DYS391: 10, DYS393: 14, DYS437: 14, DYS456: 16, DYS458: 16, DYS635: 21, and DYS385a/b:

13/14 or 12/16. We predicted the haplogroup from 10 Y-STR values (excluding DYS385a and DYS385b) of this sample by using a Bayesian-allele-frequency approach<sup>6</sup> in our Y chromosome database. The highest probability (60.18%) was for haplogroup O2\* (M268+, PK4-, M176-). The second highest probability was 13.97%, for haplogroup C3\*-M217, and the probabilities for other haplogroups were all below 11%. Furthermore, the 10 Y-STR values (excluding DYS385a and DYS385b) of YBK were exactly the same as those of the present O2\* (M268+, PK4-, M176-) samples of Anhui province in our database.

In our previous study,<sup>1</sup> we reported that six Cao clans (Tieling, Shucheng, Jixi, Yancheng, Changsha and Donggang) with Y chromosome haplogroup O2\*-M268 were suggested as being the descendants of CAO Cao. Here, we typed one more SNP, PK4, which is downstream of M268,<sup>7</sup> in the O2\*-M268 samples. However, the Cao clan of Changsha and some individuals of Shucheng were found to be PK4+. Therefore, they belong to haplogroup O2a\* (M268+, PK4+), and probably not the descendants of CAO Cao. However, the Cao clan of Rushan in Shandong province who claim to be descendants of Emperor CAO were also



**Figure 1** Median-joining network based on 15 Y-STRs (DYS19, DYS389I, DYS389II, DYS390, DYS391, DYS392, DYS393, DYS437, DYS438, DYS439, DYS448, DYS456, DYS458, DYS635 and H4) of O2\* individuals in the relevant Cao clans. YBK represents the ancient DNA sample from Yuanbaokeng Tomb I. A full color version of this figure is available at the *Journal of Human Genetics* journal online.

found to be O2\* (M268 +, PK4 -, M176 -), and therefore their claim was supported.

In order to obtain a detailed relationship of different CAO clans within haplogroup O2\*, we constructed a median-joining network based on 15 Y-STRs (17 Y-STR Y-Filer kit excluding DYS385a and DYS385b) of O2\* individuals in the relevant CAO clans (Figure 1). CAO clans from Anhui tended to be clustered closely. YBK, the ancient DNA sample, showed close affinities with CAO clans of Jixi and Bozhou. The newly discovered CAO clan in Rushan clustered with that of Donggang, matching the records of their migration history. CAO clans of O2\* seemed to be originated in Anhui province and have experienced slight population expansion, probably due to the prosperity of the Cao-Wei Kingdom.

In this study, the ancient DNA evidence supported our previous conclusion that the Y chromosome haplogroup of Emperor CAO was O2\*-M268 and also gave a clue about the ancestry of CAO Cao. Emperor CAO's father was most probably adopted from

his grandfather's own clan rather than from beggardom.

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