VIA MEDICA

ORIGINAL ARTICLE

Folia Morphol.
Vol. 74, No. 2, pp. 212–218
DOI: 10.5603/FM.2015.0033

ISSN 0015–5659
www.fm.viamedica.pl

The Turin Shroud face: the evidence of maxillo-facial trauma

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[Received 6 August 2014; Accepted 8 September 2014]

The Turin Shroud (TS) is a linen cloth commonly associated with Jesus Christ, his crucifixion and burial. Several medical specialists have debated the injuries of the TS Man, nevertheless there are no detailed and quantitative data about the anatomy of the TS face. The purpose of this study was to analyse the cephalometric measurements of the face image of the TS. The TS face image was acquired by a picture and processed using a cephalometric software, Oris Ceph® (Up to date 2012). The image of the soft tissues was processed in order to obtain skeletal points and a cephalometric analysis of the soft and skeletal tissues was performed. Image processing of the TS face shows that the Man represented in it has undergone a maxillo-facial trauma, especially a left displacement of the mandible, probably due to temporo-mandibular joint lesions. This condition has not been described before, despite several studies on the subject. (Folia Morphol 2015; 74, 2: 212–218)

Key words: facial trauma, cephalometric analysis, anthropology

INTRODUCTION

Suggestive and majestic, the face of the Turin Shroud (TS) is a highly controversial subject of studies, evaluations and interpretations. The TS is known throughout the world for its religious and scientific significance. It is a linen cloth depicting the image of a crucified man. The Christian religious community associates the image of this man with that of Jesus Christ [6, 18].

Since 1902, a series of anatomic studies on the consistency of the image of the TS and the nature of the wounds on it were made by many scientist and scholars starting with Yves Delage at the Academy of Sciences in Paris [10].

Several medical issues on the TS have been debated with the help of different disciplines as traumatology and forensic medicine. However, no studies about the cephalometric measurements of the TS face are currently available.

These types of measurements are normally taken from lateral or frontal radiographs, which are 2-dimensional just as the frontal photographic image of the TS face.

In our study, we have drawn inspiration from the anthropology, using the reverse procedure of the forensic facial reconstructions. In that field, the measurements of the face under investigation for recognition and identification are made starting from the skeletal structure found [3, 15]. In this study, once the data related to the soft tissues of the face depicted on the TS were obtained, we were able to analyse the skeletal facial structure by evaluating the craniofacial features, the possible asymmetries and any trauma, such as the ones

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of the patients undergoing orthognatic surgery [1, 2, 9, 14].

The aim of this study was therefore to analyse the cephalometric measurements of the facial image of the TS.

MATERIALS AND METHODS

Acquisition of the image

The image used for our measurements is a 1931 photograph taken by Enrie (Fig. 1), much clearer in the black-and-white negative than in its natural sepia colour. The digital image resolution was 72 dpi and the image displayed a pixel size of 0.284 mm.

The image of the face showed the measure of the height of the TS face (from the brow line to the chin) which resulted 23.4 cm. We acquired and processed the TS face image using the cephalometric software Oris Ceph® (Up to date 2012).

We performed two analysis of the TS face image:

1. Cephalometric analysis of the soft tissues. We identified 34 anatomic cephalometric points. The most significant cephalometric points of the soft tissues are listed in Table 1.
2. Cephalometric analysis of the skeletal tissues. The image of the soft tissue was processed in order to obtain skeletal points on the basis of the posteroanterior Ricketts cephalometric analysis. This procedure was based on standardised interpretation and reconstruction of the skeletal features, validated by many authors [13, 17]. We identified 23 anatomic cephalometric points. The most significant cephalometric points of the skeletal tissues are listed in Table 1.

RESULTS

Cephalometric analysis of the soft tissues

The main angular and linear measurements of the soft tissues are shown in Figure 2. The most significant cephalometric measures of the soft tissues are listed in Table 2.

These data allowed us o perform an analysis of the vertical height, the width and the symmetry of the TS face, discussed in the next section.

Cephalometric analysis of the skeletal tissues

The main angular and linear measurements of the skeletal tissues are shown in Figure 3. The most significant cephalometric measures of the skeletal tissues are listed in Table 3. These data allowed us to perform an analysis of the maxilla-mandible symmetry relation, the dento-skeletal relation, the postural symmetry and the anatomic structures of the TS face, discussed in the next section.

Figure 1. Enrie's photograph of the Turin Shroud face.

DISCUSSION

Cephalometric analysis of the soft tissues

Vertical height. Ideally, a face can be vertically divided in equal thirds by 4 horizontal lines that pass through cephalometric points known as hairline (corresponding to trichion), glabella, subnasal point and menton. The lower third of the face can be further divided into thirds with the stomion marking the inferior boundary of the upper third, and the lower lip and chin forming the lower two-thirds [7, 11, 12]. According to our results, the upper third of the TS face has a height of 46.05 mm, the middle third has a height of 80.19 mm and the lower third has a height of 54.34 mm. The height of the middle third is increased. In the TS face, the approaching of the tip of the nose to the upper lip forms a sort of "saddle nose", which is comparable to a fracture of the nasal cartilage as a result of a blunt trauma, like reported in other studies [16, 18]. Moreover, the correct height of the lower third of the TS face suggests that the TS

Table 1. Description of the most significant cephalometric points

Soft tissues		
TR	Trichion	The point where the hairline and the middle line of the forehead intersect
GC	Glabella	Midpoint of the area between the eyebrows, just above the nose
Vs	Vermilion superior	Midpoint of the upper vermilion line of the lip
Vi	Vermilion inferior	Midpoint of the lower vermilion line of the lip
MeC	Menton	The most inferior point of the soft tissue contour of the chin.
Gos	Gonion sinistrum	The most left lateral point of the soft tissue contour of the lower jaw
God	Gonion dextrum	The most right lateral point of soft tissue contour of the lower jaw
Nc	Nasion	Midpoint of the depression at the root of the nose corresponding to the nasofrontal suture
ITN	Inferior Nostril	Right/left lower point of the inferior contour of the nostril
STN	Superior Nostril	Right/left upper point of the superior contour of the nostril
AL	Alare	Right/left most lateral point of the wing or ala of the nose
SN	Subnasal	Midpoint of the base of the nasal spine, where the root of the nose and the upper lip meet
SL	Sublabiale	Midpoint of the sublabial concavity between the lower lip and the chin
ZGS	Zygomatic sinistrum	The most lateral point of the soft tissue contour of the left zygomatic arch
ZGD	Zygomatic dextrum	The most lateral point of the soft tissue contour of the right zygomatic arch
Skeletal tissues		
ACG	Apophysis crista galli	Apophysis of the crista galli
ZR	Right zygomatic-orbital point	The intersection point between the right fronto-zygomatic suture and the lateral orbital rim
ZL	Left zygomatic-orbital point	The intersection point between the left fronto-zygomatic suture and the lateral orbital rim
AZ	Right zygomatic point	The middle point of the lateral rim of the temporal process of the right zygomatic arch
ZA	Left zygomatic point	The middle point of the lateral rim of the temporal process of the left zygomatic arch
JR	Right maxilla-zygomatic point	The most concave point of the right jugal process at the intersection of the outline of the tuberosity of the maxilla and the zygomatic buttress
JL	Left maxilla-zygomatic point	The most concave point of the left jugal process at the intersection of the outline of the tuberosity of the maxilla and the zygomatic buttress
GA	Right ante-goniac point	The most concave point of the inferior rim of the right hemimandible before the goniac protuberance
AG	Left ante-goniac point	The most concave point of the inferior rim of the left hemimandible before the goniac protuberance
ANS	Anterior nasal spine	The most prominent point of the anterior basis of the nose
Me	Menton	The most inferior point of the inferior border of the symphysis of the mandible
B6	Right lower first molar	The most lateral point of the lateral surface of the right first molar crown
6B	Left lower first molar	The most lateral point of the lateral surface of the left first molar crown

man, at the time of his death, had complete, at least to his first premolars, dentition.

Widths. Ideally, a face can be divided into vertical fifths, with each fifth corresponding to the width of 1 eye. According to our results, the width of the left eye of the face of the TS (34.93 mm) is very similar to the width of the right eye (32.64 mm) as well as the width of the nose (30.07 mm). We also found a correct relation between the zygomatic width (130.23 mm) and the goniac width (112.13 mm): the cheekbone should protrude more from the goniac angle and, in the TS face, the ratio is observed.

Symmetry. To assess the proportion and the balance of the facial shape, ideally the various subunits (ears, eyes, eyebrows, nose, and lips) are symmetric if compared to the midsagittal line.

In our results, we found the lines of the right eye and of the left eye oblique and divergent; in particular, the line of the right eye forms an angle of 171.19° with the horizontal line while the line of the left eye forms an angle of 6.83°.

Also the line of the lips is not horizontal. Throughout the upper vermilion skin border, 2 paramedian elevations of the vermilion form the Cupid bow and

Table 2. Most significant measurements of the cephalometric analysis of the soft tissues

Face proportion		
1TER	Herline-glabella	46.05 mm
2TER	Glabella-subnasale	80.19 mm
3ITER	Subnasale-menton	54.34 mm
NV	Subnasale-vermilion superior	16.26 mm
VsM	Vermilion superior-menton	38.33 mm
ViM	Vermilion inferior-menton	34.15 mm
MEN	Sublabiale-menton	25.85 mm
ZIG	Zygomatic width	130.23 mm
GON	Goniac width	112.13 mm
Nose		
AL	Width of the nose	30.07 mm
NAR1	Height of the left nostril	6.86 mm
NAR2	Height of the right nostril	11.53 mm
NAR	NAR1-NAR2 difference	–4.67 mm
Eyes		
Os	Width of the left eye	34.93 mm
Od	Width of the right eye	32.64 mm
0	Os-Od difference	2.29 mm
OSX	Angle between the left eye line and the horizontal line	6.83°
ODX	Angle between the right eye line and the horizontal line	171.19°
Ears		
OR1	Height of the left ear	50.16 mm
OR2	Height of the right ear	52.88 mm
OR	OR1-OR2 difference	–2.71 mm
Lips		
AF1	Height of the left philtrum	11.42 mm
AF2	Height of the right philtrum	12.08 mm
FIL	AF1-AF2 difference	–0.66 mm
LAB	Width of the lips	26.50 mm

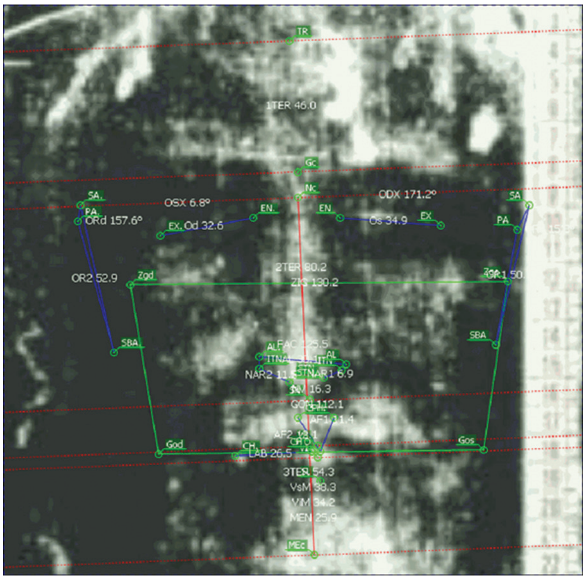

Figure 2. Cephalometric analysis of the soft tissues of the Turin Shroud face.

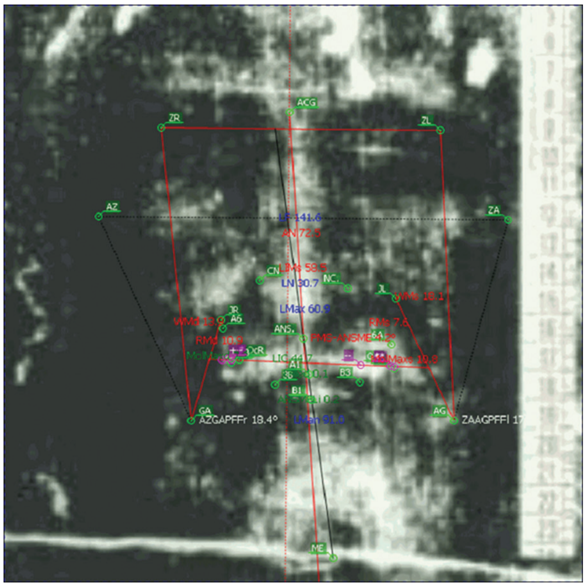

Figure 3. Cephalometric analysis of the skeletal tissues of the Turin Shroud face.

2 raised vertical columns of tissue form a midline depression called philtrum. We found a discrepancy between the height of the right and of the left paramedian elevations of the vermillion (FIL = –0.66 mm).

Cephalometric analysis of the skeletal tissues

Maxilla mandible symmetry. In a symmetric patient, the maxilla-mandible line (MML), that joints the maxilla to the mandible (from the anterior nasal spine to the menton) should coincide with the midsagittal line (0 ± 2°). In the TS face the MML forms an angle of 4.22° with the midsagittal line. This asymmetry may be caused by a shift of the mandible, by a mandibular asymmetry or by a dependency of one of the jaws.

The distance between the lower incisors' median line (Li) and the MML is 0.16 mm. This value, within the normal range, indicates the 2 lines are both deviated in relation to midsagittal line.

Maxilla mandible relation. The fronto-facial line (from the zygomatic-orbital point to the antegoniac point) is identified by the ZR-GA line on the right and

Table 3. Most significant measurements of the cephalometric analysis of the skeletal tissues

Maxilla-mandible symmetry			
WMs	Maxilla-mandible width (left)	18.07 mm	[8.50–11.50 mm]
WMd	Maxilla-mandible width (right)	13.91 mm	[8.50–11.50 mm]
PMS-ANSMe	Angle between the midsagittal line (PMS) and the line ANS-Me	4.22°	[0 ± 2°]
Maxilla mandible relation			
RMs	ZL-AG/JL	7.63 mm	[1.50 ± 1.50 mm]
RMd	ZR-GA/JR	10.88 mm	[1.50 ± 1.50 mm]
Dento-skeletal relation			
MoMaxs	Distance between left first molar (6B) and left maxilla (JL-AG)	10.76 mm	[6.30 ± 1.70 mm]
MoMaxd	Distance between right first molar (B6) and right maxilla (JR-GA)	7.32 mm	[6.30 ± 1.70 mm]
ANSMeLi	Distance between the maxilla-mandible line (MML or ANSMe) and the lower incisors' median line (Li)	0.16 mm	[1.50 ± 1.50 mm]
Postural symmetry			
ZAAGPFFl	ZA-AG/AG-ZL angle	17.87°	
AZGAPFFr	AZ-GA/GA-ZR angle	18.41°	
SIM	ZAAGPFFl-AZGAPFFr difference	–0.53°	[0 ± 2°]
Anatomic measurements			
LN	Width of the nose	30.68 mm	[42.09 ± 2 mm]
AN	Height of the nose	72.55 mm	[68.42 ± 3 mm]
LMax	Maxillar width	60.89 mm	[76.35 ± 3 mm]
LMan	Mandibular width	90.95 mm	[109.48 ± 3 mm]
LF	Facial width	141.65 mm	[173.40 ± 3 mm]

the ZL-AG line on the left. The distance between the fronto-facial line and the zygomatic point itself (JR and JL) indicates the position of the mandible to the maxilla, regarding a possible skeletal cross-bite. As the distance ZR-GA/JR is 10.88 mm while ZL-AG/JL is 7.63 mm, a deviation due to a shift of the mandible on the left side can be considered. These measurements are schematized in Figure 4.

Dento-skeletal relation

The distance (Maxd and Maxs) between the lower molars and the maxilla (JR-GA or JL-AG) is another indicator of possible cross-bites. The position of the lower molars was automatically determined by the software starting from the anatomic visible structures. We observed a major distance between the lower molars and the maxilla on the left, which confirms the left displacement of the mandible. On the left (Maxs = 10.76 mm) there is an increase of +2.76 mm when compared to the right (Maxd = 7.32 mm). This seems to confirm the skeletal cross-bite due to a shift of the mandible on the left side.

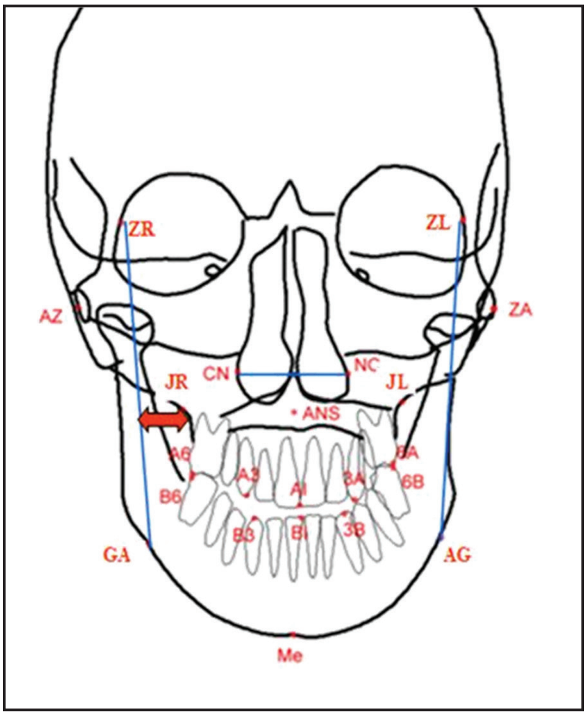

Figure 4. Maxilla mandible relation (scheme).

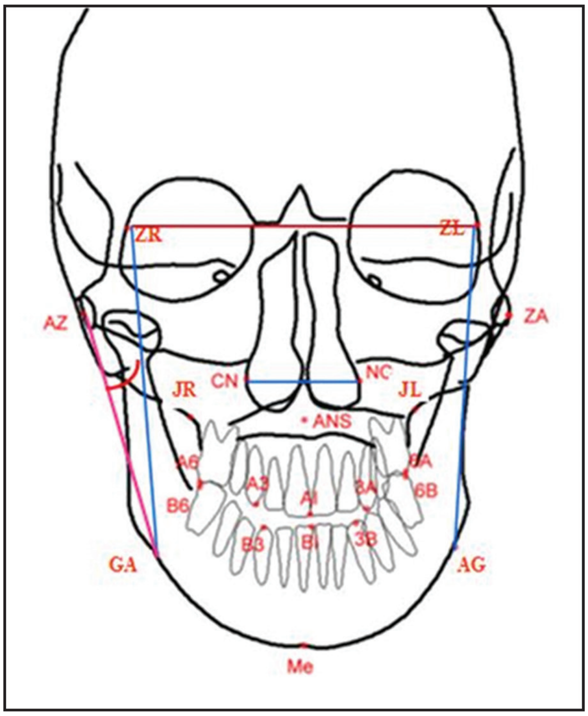

Figure 5. Postural symmetry (scheme).

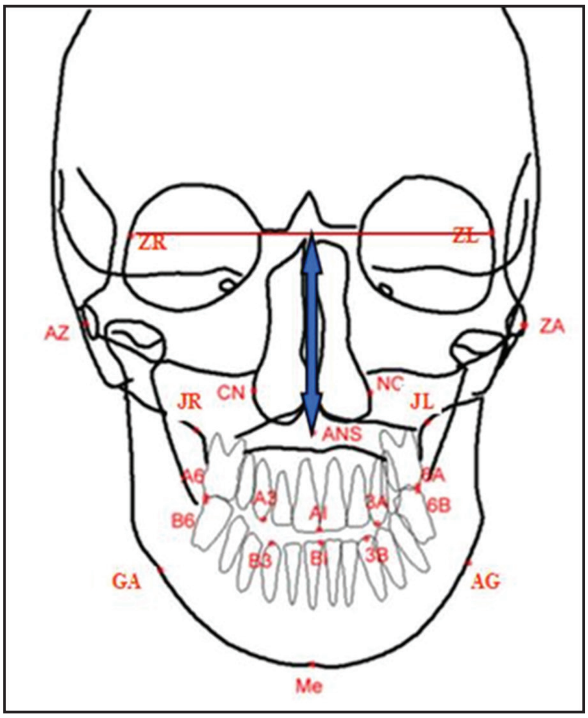

Figure 6. Increase in the height of the nose (scheme).

Postural symmetry

The angle between the fronto-facial line (ZR-GA and ZL-AG) and the line from the zygomatic point to the ante-goniac point (AZ-GA and ZA-AG) is an indicator of postural asymmetries. We found the right angle (18.41°) greater than the left one (17.87°). Even if the discrepancy (0.53°) is in the normal range, this data could confirm, along with the other findings, the shift of the mandible. These measurements are schematized in Figure 5.

Anatomic structures

If compared with standard ranges, the width of the nose is correct (30.68 mm) while the height of the nose (from the anterior nasal spine to ZL-ZR line) is increased (72.55 mm). This result confirms the "saddle nose" (Fig. 6). The facial, maxillar and mandibular widths are inside the standard value ranges.

The new data about the TS face pointed out by this study is the presence of a mandibular asymmetry. The aetiology of the facial asymmetry may include genetic or congenital malformations (e.g. hemifacial microsomia and unilateral clefts of the lip and palate), environmental factors (e.g. trauma and habits) and functional deviations (e.g. dental interferences) [5, 8]. A recent study indicated that the man represented in the TS suffered a undeniable violent blunt trauma to the neck, chest and shoulder from behind, causing neuromuscular damage and lesions of the entire brachial plexus [4]. Thus, considering the TS face as a polytraumatised face, we can assume that the displacement of the mandible — fairly too large to be structural — was caused by the trauma itself, i.e. temporo-mandibular joint lesions. Bevilacqua affirmed that all the evidence is in favour of the hypothesis that the TS Man is Jesus of Nazareth. Even the facial trauma highlighted by the present study is confirmed by the description of Jesus's Passion. In fact, the facial trauma could be caused by a strike on the face which is often reported in the Gospels [Mattew 26:67 "Then they spit in his face and struck him with their fists. Others slapped him." — John 18:22 "And when he had thus spoken, one of the officers which stood by struck Jesus with the palm of his hand."].

CONCLUSIONS

To the authors' knowledge, this is the first cephalometric analysis of the face of the TS. From our data, there are evidences that the face depicted on the TS underwent a maxillo-facial trauma, resulting in a fracture of the nasal septum and especially in a displacement of the mandible, probably caused by temporo-mandibular joint lesions.

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