ABSTRACT

Prehistoric human skeletal remains from Later Stone Age archaeological sites, South Africa, were examined for evidence of habitual use of a squatting posture during life. Bony facets that are believed to be associated with habitual squatting were identified on the tali and the proximal tibial condyles of adult bones. The sample (n=98 adults) was found to exhibit the highest frequency yet reported of the lateral F squatting facet on the talus. A high frequency of medial traits is also reported, including both the medial squatting facet and medial condylar rounding, which have been rare in other populations. There is no statistically significant difference in the expression of traits by broadly defined time periods, age at death, or sex. Individuals from the same region show similar patterns of squatting facets, but there is considerable inter-regional variation among the Western Cape, the Southern Cape, and the Eastern Cape. The pattern of traits related to squatting postures is consistent with lean body builds, in which there is little soft tissue resistance to deep joint flexion. Most adults appear to have regularly assumed the squatting posture, but there may have been regional differences in stance preferences.

Keywords: talus, squatting facets, Khoesan, Holocene, hunter-gatherers, pastoralists.

Introduction

It is worthwhile identifying those characteristics of human behaviour that manifest themselves within the skeleton. If a population commonly shows a particular trait or group of related traits, this information can be used in the assessment of newly discovered skeletal remains of uncertain cultural context. Subtle details of behavioural traits can help to identify temporal and spatial differences among populations. Further, evidence of individual volitional behaviour contributes to our understanding of an aspect of humanity in the past.

This study was undertaken to determine whether Later Stone Age individuals from South Africa habitually assumed a squatting posture when resting or when working in a seated position. Historic accounts of Bushmen and photographic images show that squatting is a common postural behaviour among foragers of southern Africa (cf. images of the Dobe !Kung of the Kalahari region; Figs 1 & 2). We anticipate that prehistoric foragers of southern Africa also regularly utilized this position.

The idea that skeletal remains could reveal evidence of individual positional behaviour was first addressed by Thomson in 1889. He tested the hypothesis that the squatting posture could be detected in the ankle and knee joints on skeletal remains. Since this pioneering study (Thomson 1889, 1890) there have been several others (Charles 1893, 1894; Sewell, 1904a, 1904b, 1905; Wood 1919-20; Martin 1932; Barnett & Napier 1952; Barnett 1954; Singh 1959, 1963; Kate & Robert 1965; Rao 1966; Satinoff 1972; Oygucu et al. 1998; Boulle 2001a, 2001b). The largest studies have been conducted on recent colonial samples from India and Australia. Studies of large prehistoric samples have been less common, the only other study of skeletons from the African continent being of Egyptians (Satinoff 1972). This lack of data from prehistoric contexts is notable as Boulle (2001a) has argued that the incidence of squatting facets in Europeans increases as one goes back in time, from modern to medieval samples.
acquisition of facets and any genetic propensity (Singh 1959, 1963) and for the facets’ representing genetically inherited traits (Charles 1893, 1894). The modern consensus is that squatting facets develop as a result of hyperdorsiflexion of the ankle, with all human populations showing the potential for their development (Trinkaus 1975; Boulle 2001b).

A consequence of regular squatting is the development of supernumerary surfaces or articular facets on the proximal and distal tibia and on the talus due to the hyperdorsiflexion of the ankle and hyperflexion of the knees (Thomson 1889; Satinoff 1972; Trinkaus 1975; Ubelaker 1978; Boulle 2001a, 2001b), as postural stress alters the articular morphology of joints (Martin 1932; Trinkaus 1975; Ubelaker 1978, 1979) (Fig. 3). During squatting, the talus, and therefore the foot, deviates laterally with respect to the tibia (Barnett & Napier 1952) and the weight of the individual causes the formation of lateral facets on the talar neck. These supernumerary articular facets are covered by a cartilaginous layer and are subsequently visible on the dry bones as dense, smooth areas of cortical bone that are easily distinguished from the surrounding irregular, porous, non-articular surfaces (Trinkaus 1975). While Trinkaus (1975) suggests that intensive physical activity may loosen the ligaments surrounding the ankles and thus allow a wider range of joint movement, one would still need to be in extreme hyperdorsiflexion for the surfaces of the talus and tibia to come into contact and form supernumerary facets. The relatively low frequencies of talar and tibial squatting facets in modern populations are also consistent with the postulation that squatting facets are caused by squatting (2% in a modern European sample; Barnett 1954).

Following Barnett’s (1954) classification, Fig. 4A shows a ‘normal’ talus without any modification. Figs. 4B-D illustrate trochlear extensions; 4B is the forward extension of the medial articular surface beyond the anterior margin of the trochlea, 4C and 4D are the medial and lateral extensions respectively of the trochlear surface. Figs 4E & F illustrate the true medial and lateral squatting facets: A medial squatting facet is located on the distal aspect of the talar neck on the medial margin and is distinct from the trochlear surface. This facet is very rare. A lateral squatting facet is found on the distal aspect of the talar neck on the lateral margin and is either separated from the trochlear surface by a distinct groove or continuous with the trochlear surface, ‘though always making a sharp angle with the line of curvature’ (Barnett 1954: 510). Satinoff (1972) also identifies the E and F squatting facets, depending on whether they are separate distinct facets or if they are combined (Fig. 5).
Modifications to the knee joint due to hyperflexion can also be observed. Medial rotation of the tibia during hyperflexion causes the lateral femoral condyle and its meniscus to displace onto the posterior margin of the lateral tibial condyle, causing rounding on the posterior aspect of the tibial condyle (Trinkaus 1975) and flattening of the superior posterior aspect of the medial femoral condyle (Charles 1893). In this study, the sample size of tibiae (n=40) is greater than that of the femora (n=36), so the proximal tibiae are used for observation of this feature.

**Results**

The study sample of 98 partial or complete skeletons (Appendix) yielded observations on 75 mature tali and 40 tibiae (one per individual in each case). Each of the tali exhibits expression of the B extension. That is, the A condition was not seen. The presence of the C and D extensions are also high at 89% and 97% of the sample respectively. Because positional behaviours other than squatting, such as supination (kneeling and sitting on one’s feet), can also create these extensions, exploration of the squatting posture must rely on quantification of the squatting facets, that is, the E and F facets of the talus. The Later Stone Age sample exhibits a nearly ubiquitous expression (99%) of the lateral talar facet or F facet while the expression of the E facet is found in 60% of the sample. Variability also exists in the morphology of the E and F facet with respect to each other. Nearly half of the tali with both E and F facets exhibit combined facets, while the remaining individuals exhibit separate facets.

The tibial data (n=40) are consistent with the talar results, indicating the use of squatting. Ninety percent of the sample exhibits rounding on the lateral tibial plateau and 50% of the sample exhibits rounding on the medial tibial plateau.

There are no statistical differences in the expression of traits among young, mid and old adults ($\chi^2=1.02, 2$ df, $p>0.05$ for the E facet; $\chi^2=1.23, 2$ df, $p<0.05$ for combined versus separate E and F facets; and $\chi^2=2.7, 2$ df, $p>0.05$ for tibial condyle rounding). There are also no statistically significant differences between men and women ($\chi^2=0.09, 1$ df, $p>0.05$ for the E facet; $\chi^2=0.23, 1$ df, $p>0.05$ for combined versus separate E and F facets; and $\chi^2=1.2, 1$ df, $p>0.05$ for the tibial condyle rounding).

As we compare results temporally, there are no statistical differences in the expression of the medial squatting traits by era of death ($\chi^2=4.45, 2$ df, $p>0.05$ for frequency of E facet; $\chi^2=3.3, 2$ df, $p>0.05$ for combined versus separate E and F facets) with the exception of the rounding on the tibial condyles ($\chi^2=10.2, p<0.01$). Tibiae from individuals dated at greater than 3000 years BP exhibit an even distribution of tibial rounding, half exhibiting rounding on the lateral condyle and half on both condyles. Between 3000 and 2000 years BP this changes and most individuals (73%) exhibit the same condyle rounding. Finally, within the past 2000 years, the dominance changes, with 86% exhibiting rounding on the lateral condyle alone.

With regard to regional differences (Table 1), the Western Cape sample (n=15) exhibits a low frequency of the E facet, a predominance of separate E and F facets when they are present, and predominance of rounding on both tibial condyles. The Southern Cape sample (n=44) exhibits a high frequency of the E facet, prevalence of separated E and F facets and only 50% of tibiae with rounding on both tibial condyles. Finally, the Eastern Cape sample (n=17) has the highest frequency of E facet, a dominance of combined E and F facets and rounding on the lateral condyle of most tibiae.

**Discussion**

In comparison with published results from other samples,
skeletons from the Later Stone Age show frequencies comparable to the highest reported for talar facets. Comparative values for the B extension range from 91% to 100%; the frequency of the C extension ranges from 11% to 79%, and the D extension ranges from 54% to 90% (Barnett 1954; Charles 1893; Singh 1959, 1963; Satinoff 1972; Wood 1919-1920). The same can be said for squattting facets E and F. The Australian sample (n=238) had a frequency of 33.6% for the F facet and 1.2% for the E facet (Rao 1966); the Punjabi sample (n=300) had a frequency of 28.6% for the F facet and 0.33% for the E facet (Singh 1959); while the ancient Egyptian sample (n=300) exhibited a frequency somewhere between 32% and 96% for the F facet, depending on how one reads the data, and 32% for the E facet (Satinoff 1972).

Table 1. The frequency and morphology of traits by region.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Western Cape</th>
<th>Southern Cape</th>
<th>Eastern Cape</th>
</tr>
</thead>
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<tr>
<td>E facet</td>
<td>5/14</td>
<td>28/44</td>
<td>12/17</td>
</tr>
<tr>
<td>EF combined</td>
<td>4/5</td>
<td>9/28</td>
<td>8/12</td>
</tr>
<tr>
<td>E&amp;F separated</td>
<td>1/5</td>
<td>19/28</td>
<td>4/12</td>
</tr>
<tr>
<td>Tibia Lateral rounding</td>
<td>2/12</td>
<td>5/10</td>
<td>12/15</td>
</tr>
<tr>
<td>Both rounding</td>
<td>10/12</td>
<td>5/10</td>
<td>3/15</td>
</tr>
</tbody>
</table>

E facet: number of tali that express the E facet. EF combined: number of individuals that exhibit both the E and F facets in the form of one continuous facet. E&F separated: presence of both the E and F facets as separate facets. Lateral rounding: individuals that exhibit rounding on only the lateral condyle. Both rounding: individuals with rounding on both condyles.

Thus, it seems that squatting was ubiquitous among Later Stone Age South Africans. The absence of significant differences among age classes suggests that habitual positional behaviours were adopted early in life. Results also indicate similar patterning between men and women. The wealth of skeletal postural indicators from the ankle and knee region suggest that body mass was sufficiently low that there was little soft tissue to obstruct the deep flexion of the joints. During normal squatting, the talus deviates laterally with respect to the tibia (Barnett & Napier 1952) and the weight of the individual causes the formation of the lateral traits on the talar neck. At the same time, the femora deviate laterally with respect to the tibia (Barnett & Napier 1952) and the weight of the individual causes the formation of the lateral traits on the talar neck. The high frequency of medial traits on both the talus and tibia suggests that while prehistoric South Africans were using ‘normal’ squatting, some individuals were also utilizing a modified squatting position or some unidentified position. Perhaps these people had more flexible joints than those studied elsewhere and were able to freely move the joints while squatting.

With regard to the patterning found between the E and F facets, Satinoff (1972) postulated that one would find them either as separated units or combined into one facet (Fig. 5). The reasons for the formation of separate versus combined E and F facets are difficult to determine with confidence. Perhaps individuals supinated their feet while squatting or sat with one leg bent. Ethnographic studies of the modern Dobe !Kung observed that individuals were able to supinate their feet while squatting (Fig. 2). Supination during squatting would transfer an individual’s weight onto the medial side of the talus, forming medial facets. One possible reason for the formation of separate facets is that the meniscus capsule, which surrounds and protects the articular surfaces of the ankle joint, encroached upon the talar neck, preventing fully formed combined facets.

Variability is seen in the expression of the medial traits such as the frequency of the E facet, the morphology of the E facet with respect to the F facet, and the morphology of the tibial condyles. The apparent changes through time in the pattern of tibial condyle rounding are unexpected as they do not correspond with any of the other traits. However, the data mimic the results for inter-regional variation and may reflect the archaeological visibility of burials in the different regions, rather than a fluctuation through time throughout southern Africa. The skeletons available for study from the three regions are not evenly distributed temporally. For example, 11 of the 15 individuals in the 2000-400 yrs BP category are from the Eastern Cape. The dominance of rounding on the lateral condyle that is associated with the Eastern Cape may reflect a regional difference or it may reflect a temporal one. Reasons for proposing that the differences are more appropriately seen as regional rather than temporal include the observation that no other traits studied here exhibit a significant temporal difference whereas both the distribution of the E facet and the morphology of the E and F facets do change between regions in accordance with the tibial data. Furthermore, previous studies of skeletal remains from the three regions have suggested inter-regional differences in rugosity of muscle insertion sites (Churchill & Morris 1998) and patterns of upper limb robusticity (Stock & Pfeiffer 2004). Nevertheless, a more nuanced analysis might clarify the interaction between region and time in postural preferences.

**Conclusions**

The high frequency of the expression of talar extensions and squatting facets, as compared to other studies, suggests that Later Stone Age adults habitually hyperdorsiflexed their ankle joints. Indications of postural behaviour are clearly established by early adulthood and are similar in men and women. The common presence of facet extensions, separate facets and rounded joint surfaces suggests that body mass was lean, so that joint flexion was unhindered. A physically vigorous lifestyle may have contributed to ligamentous flexibility as suggested by Trinkaus (1975), further supporting the development of squatting facets. The skeletons in this sample exhibit a high frequency of medial traits in comparison to studies of other populations. The presence of the talar E facet suggests that some individuals were utilizing the medial aspect of the ankle joint often enough to create supernumerary facets. In some individuals, the E and F facets are combined, most likely due to habitual postural stress directed onto the centre of the talar neck, either by direct pressure or by repeated supination of the feet during squatting or by utilizing some other unidentified positional behaviour in conjunction with normal squatting.
The morphology of the knee joint indicates that some adults were following habitual behaviours other than normal hyperflexion. Normal hyperflexion in the knee joint is indicated by rounding on the lateral tibial condyle and several individuals have rounding on both condyles. This is consistent with the talar data in suggesting that some individuals were utilizing positional behaviours that caused lateral tibial rotation. We suggest that supination while squatting occurred, leading to this pattern.

While there is a statistically significant difference in the expression of the tibial rounding through time, this result may be a function of the differences in the antiquity of skeletons from the three regions. There are statistically significant differences among the Western Cape, Southern Cape and Eastern Cape in the expression of the E facet, the morphology of the E and F facets and the morphology of the tibial condyles. Thus, this study suggests that there may have been variation in how people behaved across the landscape. While most of the skeletons examined in this study represent foragers, some of those from less than 2000 years ago may represent pastoralists. Since the regional groupings used in this study include skeletons that are not identical in their antiquity, the three regions may include different ratios of forager and pastoralist peoples. As further research identifies ways to distinguish prehistoric lifeways, the postural indicators explored in this research may be useful in helping to differentiate groupings.

This study has identified which lower limb postural indicators are ubiquitous and which are variable in adult skeletons from foragers and putative pastoralists of pre-European southern Africa. The variability may be a function of regional terrain, physique and activities of daily living. Other approaches to the reconstruction of prehistoric behaviour in southern Africa could benefit from incorporating these indicators of postural behaviour as we work toward understanding past behavioural adaptations.

Acknowledgements

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References

Appendix. Details of the individuals studied from the Western Cape (WC), Southern Cape (SC) and Eastern Cape (EC). The grouping by antiquity is based on either direct ^14C dates or contextual association. The group designated >2000 all fall in the latter group. Institutions (after Morris 1992): NMB - National Museum Bloemfontein; ALB - Albany Museum; SAM - Iziko South African Museum; UCT - University of Cape Town. Estimated ages: young adult (YA), mid adult (MA), Old adult (OA), and adult (A). Element studied: tibia (Tib) and talus (Tal).

<table>
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<th>Catalogue No.</th>
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<th>Est. Sex</th>
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<th>Burial context/position</th>
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<td>Tal</td>
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3000-2000 BP

<p>| ALBS0 | MA | M | Tal, Tib | Plettengberg Bay, SC | cave |
| ALB222 | YA | M | Tal, Tib | Cape St. Francis, EC | sand dunes |
| NMB1639 | A | F | Tal, Tib | Robberg, SC | long block A, ~2ft deep |
| NMBMSk2 | A | F? | Tal | Matjes River, SC | cave |
| NMBSk1 | A | F? | Tal, Tib | Matjes River, SC | cave |
| SAM-AP1443 | A | M | Tal, Tib | Tow’s River mouth, SC | no data |
| SAM-AP1878A | A | M | Tal, Tib | Gordon’s Bay, WC | no data |
| SAM-AP1889 | A | M | Tal | Robberg, SC | Cave E |
| SAM-AP1893 | A | M | Tal, Tib | Robberg, SC | no data |
| SAM-AP4305 | A | M | Tal, Tib | Noordhoek, WC | surface of midden in dunes |
| SAM-AP4720 | A | M | Tal, Tib | Kommetjie, WC | no data |
| SAM-AP4825 | A | F | Tal, Tib | Tucker’s Cave, SC | cave, number 2 |
| SAM-AP4943 | A | F | Tal, Tib | Kommetjie, WC | no data |
| SAM-AP5075 | A | M | Tal, Tib | Cape Point, WC | rockshelter, found during construction of new bridge |
| SAM-AP5095 | A | F | Tal, Tib | Saldanha Bay, WC | midden on dune |
| UCT162 | A | M | Tal | Ysterfontein, WC | sand dune, flexed on side |
| UCT222 | A | M | Tib | Stompneusbaai, WC | sand dunes |</p>
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<td>Farao-skop, WC</td>
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<td>&gt;2000 BP</td>
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<td>ALB126</td>
<td>YA</td>
<td>M</td>
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<td>Port Alfred, EC</td>
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<td>covered by single stone on head</td>
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<tr>
<td>ALB282</td>
<td>YA</td>
<td>F</td>
<td>Tal</td>
<td>Plettenburg Bay, SC</td>
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<td>found while excavating house foundation</td>
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<td>ALB323</td>
<td>OA</td>
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<td>midden in dune sand, flexed on left side</td>
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<tr>
<td>ALB328</td>
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<td>Tib</td>
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<td>Bushman’s River, EC</td>
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<td>sitting flexed, found building drains for new home</td>
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<td>ALB353</td>
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<td>M</td>
<td>Tal</td>
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* * *