1.0 Introduction

Numerous studies have used enthesal changes (ECs, see Fig. 1-2) to infer muscle use based on the visual expression of these changes to the skeletal attachments of muscles and other soft tissues (entheses). A previous meta-analysis [1] demonstrated that, in general, sample sizes of individual studies are small: a clear problem when inferring activity-patterns from an indicator which has a multi-factorial aetiology of which age the ageing process is the most significant factor.

One method that has been proposed to reduce the effect of ageing when comparing populations is to compare EC frequency within individuals. This has been previously done in a study looking at two muscles and found a reversal of agonist/antagonist muscle (i.e. the muscles which, respectively, move and stabilise the joint) ratios for the common extensor and flexor origins in the Palaeolithic which they inferred to be associated with differential activity patterns [2].

The aim of this poster is to present a meta-analysis of agonist/antagonist ratios by subsistence strategy for the most commonly recorded upper limb entheses. Due to missing data (within and between publications), this will not completely mitigate against the impact of variation in demographic profiles of samples, but it will identify periods which may have unusual activity patterns.

Agonisn Antagonist Action (simplified) Enthesis anatomy
Infraspinatus Subscapularis Rotation at shoulder Fibro-cartilaginous
Teres minor Teres major Rotation at shoulder Fibro-cartilaginous
Deltoid Latissimus dorsi Moves arm in and out and from side of body Fibro-cartilaginous
Common extensor origin Common flexor origin Moves arm in and out and from side of body Fibro-cartilaginous
Brachioradialis Triceps brachii Muscles and tendons elbow Fibro-cartilaginous
Pronator teres Supinator Turn palm facing up and down Fibro-cartilaginous

3.0 Materials and Methods

Two terms “musculoskeletal stress markers” and “enthesal changes” were searched for in Google Scholar and all publications found were listed in a spreadsheet. All papers were searched for usable data, e.g. raw data, EC frequencies and means by enthesis. Raw data were converted to frequencies or means, depending on the method.

Pivot tables were used to summarise the data by subsistence strategy (identified from the original paper), sex, enthesis, side and statistic presented (mean or frequency). For presence/absence data real numbers were used. Pivot tables were used to calculate averages for the mean scores. This does not take into account the sample size, and is a limitation of this method.

For the purposes of this study only six pairs of entheses were used, as these are the most commonly recorded (Table 1).

3.1 Results and Discussion

The search found over 160 papers, the majority of which were not relevant for this study (e.g. entheses only mentioned once, wrong species or focussed on the lower limb): 38 were relevant but did not present data in a usable format; and 30 presented data in a usable format and were included [2-31].

The pivot tables summarised in Figs. 3-11 demonstrate:
1) There is a trend for one muscle to have higher scores/frequencies of ECs (Table 1):
   - This may indicate which muscles are most likely to be overloaded or may reflect differential EC prevalence caused by underlying enthesis morphology.
2) Occasionally reversals of this general trend occur:
   - For the entheses associated with extension/extension of the hand in males show for all methods, in the right side for hunter-gatherers consistent with previous research [2]. But mean scores show for this all male activities, but only in the right hand, but it is only limited to two subsistence strategies for the frequency data. This may be associated with methodological issues or limitations, but is likely to represent increased function in the activities of the samples.
3) In contrast to a previous meta-analysis [1] hunter-gatherers generally have lower means and EC frequencies than agriculturists. This change may reflect use of a larger data set (4 extra papers [10, 13, 16, 25]) which has increased sample sizes or different populations and activities included in these papers.

4) Limitations:
   - Recording method plays a part. Only three papers used an anatomically appropriate method to record enthesis, which is limited to fibrocartilaginous entheses [2, 12, 26].
   - Sample sizes were often small, for some variables. These were limited due to the small number of papers which publish data in a format which can be more widely used.
   - These limitations are exemplified in the reversal of the general trend for teres min./maj. Mean scores presented teres major as the agonist, while teres minor was the agonist for the frequency data. Only 3 papers provided data for this latter graph, all of which (like the mean scores) used non-anatomically appropriate recording methods [3, 6, 8].

4.0 Conclusions

This study has revealed interesting trends in EC presence by agonist/antagonist muscle groups. Most importantly trends in direction of use are the same for all subsistence strategies but some anomalies are present which may point to a significant difference in muscle use. While the general trend may not reflect muscle loading, but may instead be caused by normal morphology, when this trend is reversed it should be considered important. Nevertheless these results should be interpreted in light of the limitations acknowledged in sections 1 and 3.

References