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Bony hypertrophy of the forearm in bareback rodeo athletes

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Abstract

Objective: Activities that require increased load bearing are known to cause bony hypertrophy. This phenomenon has been documented in the dominant arm of athletes in sports requiring significant utilization of a single limb. The literature addressing this effect in rodeo athletes, however, is minimal. Studies evaluating rodeo athletes are primarily focused on acute injury management rather than chronic symptoms resulting from changes in bone and soft tissue. We designed a study to evaluate bony hypertrophy in athletes without acute injury.

Method: Rodeo bareback riders presented with frequent pain in their grip arm, no radiographic evidence of injury, and clinical signs of peripheral nerve compression. Anteroposterior and lateral X-rays taken for initial evaluation in 17 bareback rodeo athletes were retrospectively reviewed. The diameter of bilateral ulnas was measured at its longitudinal midpoint. Ratio of Ulnar Diameters (grip arm/free arm) and Percentage Diameter Difference were calculated. An independent samples *t*-test was used to assess differences in diameters of grip and non-grip arms.

Result: The mean ulnar diameter was 18.4 ± 3.5 in the grip arm and 16.6 ± 3.5 in the non-grip arm ($p < 0.001$). The mean ratio of grip to free arm ulnar diameter was 1.42 ± 0.21 (range = 1.05–1.92). The mean diameter percent difference measured 42.3% (range = 4.7%–92.0%), and the grip arm was observed to have a greater ulnar diameter compared to the non-grip arm.

Conclusion: There are significant anatomic differences in the grip arm of bareback rodeo athletes compared to the contralateral arm. In cases of persistent pain in the grip arm and no evidence of acute injury, these differences may be relevant to pain symptoms and should be considered as part of the assessment and treatment algorithm.

Keywords

Bone hypertrophy, orthopaedics/rehabilitation/occupational therapy, radiology, radius hypertrophy, rodeo, sports medicine, ulnar hypertrophy, unilateral loading, Wolff's law

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Introduction

Activities that necessitate increased load bearing are known to cause bony hypertrophy. In keeping with Wolff's law, bones increase in size and density in response to activities causing increased stress.[1] Many studies have demonstrated this phenomenon in the realm of sport, specifically tennis: Huddleston et al.[2] demonstrated that the radius bone mineral content in the playing arm was measured to be 11.4% greater than that of the non-playing arm; Haapasalo's group[3] found that the cortical wall thickness of the radial shaft was demonstrated to be 4.5% larger in the grip versus non-grip arm of male tennis players; Ducher et al.[4] observed a 9.1% increase in total area of the humerus in the grip arm in comparison to the non-grip arm in post-menarcheal women players. The literature indicates an occurrence of unilateral hypertrophy from sports requiring significant unilateral load bearing.

While there has been evaluation of unilateral hypertrophy in sports such as tennis,[2] baseball,[5] and field hockey,[6] the current literature investigating this phenomenon in rodeo athletes is limited.[7] Due to the dangerous nature of rodeo competitions, much of the research surrounding these athletes is directed at management of more acute injuries.[8–10] However, one study evaluating 82 abnormalities found in X-rays of the upper extremities found ulnar hypertrophy, healed stress fractures, degenerative joint disease (DJD), calcification, a posterior

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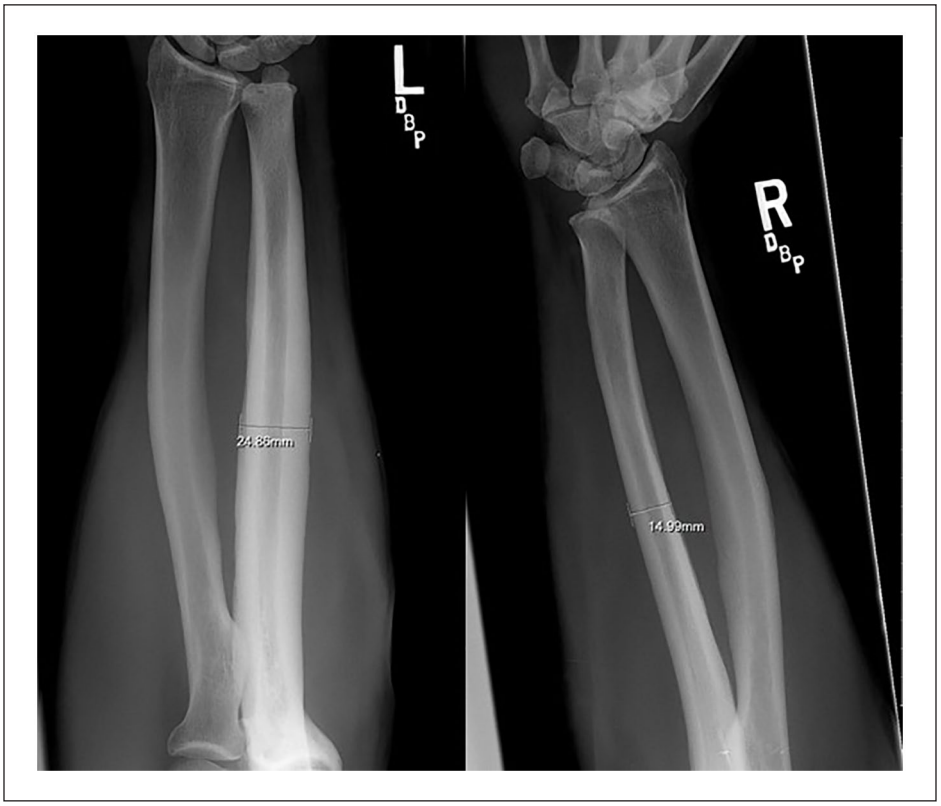

Figure 1. Bilateral X-rays of grip versus non-grip arm.

olecranon tip fracture, and medial collateral ligament (MCL) traction spurs in the forearms and elbows of rodeo athletes, suggesting an underlying chronic osseous stress which predisposes them to injury.[11] An earlier study of 56 rodeo athletes showed visible unilateral ulnar hypertrophy and associated soft tissue hypertrophy, although objective measurements and/or statistical analysis were not reported.[7] These patients presented with soreness in the grip arm which did not diminish with padding, but resolved with retirement from the rodeo.[7]

As part of the sports medicine team serving the rodeo circuit, the authors are not only evaluating these patients for acute injuries but also monitoring chronic injuries and playing an important role in their overall health and welfare. Bareback riders seen by our team often present with complaints of chronic arm pain and no evidence of acute injury. The following study evaluates bony forearm hypertrophy in rodeo athletes and its possible implications for clinical decision-making in treatment of these athletes. We hypothesized that the grip arm in these athletes would demonstrate bony hypertrophy and osseous changes compared to the non-grip arm.

Methods

The study was conducted in accordance with the ethical standards of the Helsinki Declaration of 1975, as revised in 2008. Bilateral forearm anteroposterior (AP) and lateral X-rays taken from January 2017 to December 2018 for evaluation of complaints of persistent pain in the grip arm of adult (>18 years of age) rodeo athletes were retrospectively reviewed (Figure 1). Left and right radiographs were taken on the same day for a single patient with the same protocols and positioning for contralateral arms. Patients were excluded if X-rays showed evidence of fracture or ligament injury in the affected limb.

All contralateral ulnar measurements were obtained by a single orthopedist who did not participate in data analysis for comparison between grip and non-grip arms. Measurements were randomized between conditions (e.g. the observer was blinded to grip vs non-grip arm). The diameter (mm) of both ulnas was measured at its longitudinal midpoint (between the distal styloid and proximal olecranon) as this was expected to be greater if bony hypertrophy was present.[3] Three serial measurements were taken for each bone and the median measurement was used for subsequent analysis to reduce intraobserver variability. Ratio of Ulnar Diameters (grip arm/free arm) and Percentage Diameter Difference (grip arm/free arm – 1) were calculated for each patient.

Statistical analysis

Given the retrospective nature of this study, limited number of X-ray images available, and lack of quantitative measurements in the literature assessing bony hypertrophy in bareback rodeo athletes, a priori power analysis was not

Figure 2. Soft tissue hypertrophy in grip arm.

performed. An independent samples *t*-test was performed to determine if the diameters of grip and non-grip arms differed significantly. An alpha level of 0.05 was used as the threshold for statistical significance. Cohen's *d* was used to determine effect size, with a *d*-value of 1 indicating that the magnitude of difference between two grip and non-grip arms is equal to 1 standard deviation.[12] Effect sizes of 0.2, 0.5, and 0.8 are considered small, medium, and large, respectively.[12]

Ratio of Ulnar Diameters (grip arm/free arm) and Percentage Diameter Difference were calculated for each patient. Mean ratios and percentages were calculated, along with standard deviations and coefficients of variation for Ulnar Diameters and Percentage Diameter Difference.

Results

Seventeen patients met inclusion criteria. All patients were male and over the age of 18 years. The mean ulnar diameter was 18.4 ± 3.5 in the grip arm and 16.6 ± 3.5 in the non-grip arm. The coefficients of variation for grip and non-grip arms were 13.4% and 11.1%, respectively. *T*-tests showed a significant difference between the diameter of grip and non-grip arms in these athletes ($p < 0.001$, effect size (D) = 2.77). The mean diameter percent difference in the grip arm versus non-grip arm was measured to be $42.3\% \pm 20.9\%$ (range = 4.7%–92.0%). The mean ratio of grip to free arm ulnar diameter was 1.42 ± 0.21, and the ratios were normally distributed. Although measurements were not taken to measure soft tissue differences between grip and non-grip arms of these athletes, visible size discrepancy was noted in all patient charts. In some cases, clinical photographs were available for assessment of overall hypertrophy (Figure 2).

Discussion

Given the high stress placed on the grip arm of rodeo athletes, there are anatomic differences in the bone that should be considered when evaluating these athletes and making clinical decisions. In this study, we show that bony hypertrophy in the ulna of the grip arm of bareback rodeo riders was 42.3% greater on average when compared to the non-grip arm, which is nearly a 10-fold greater difference (between right and left) in forearm bone thickness than a previous study on tennis athletes.[3] The disproportionate degree of diameter difference in comparison to other sports may result from the arms of rodeo athletes bearing a significantly larger load when maintaining position on top of bucking livestock.

Given what we know about increased load and soft tissue hypertrophy, a principle outlined by Frost, it is reasonable to expect that the bony hypertrophy measured in our patients was accompanied by soft tissue hypertrophy.[13] Soft tissue hypertrophy may be clinically relevant in this population as a predisposing factor for compressive neuropathies.[14] Bone and/or soft tissue hypertrophy may compress adjacent structures, potentially contributing to the unilateral pain that these athletes experience in instances where there is no radiographic evidence of injury. Physical exams in this study suggested that their symptoms were related to compressive neuropathy in the radial, median, and ulnar distributions.

Harrelson and Newman[15] indicated compression of the ulnar nerve occurred as a result of hypertrophy of the volar carpal ligament and/or accessory muscles caused by extreme valgus stress at the elbow. Entrapment of the median nerve was identified in a separate study to be a result of compression from muscle hypertrophy in racquet sports and strength training.[16]

This study is limited by the inclusion of only symptomatic patients. We were unable to account for previous injuries that may have influenced the bone composition of either arm. Furthermore, we are unaware if the athletes participated in other activities requiring increased stress to the grip arm. This study did not include athletes from other sports (e.g. tennis, baseball, or hockey) for direct comparison of the degree of hypertrophy seen in rodeo versus other sports.

Claussen[7] postulated that repetitive impact of the ulna on the pelvis may be responsible for bony hypertrophy seen in his patients; however, padding did not improve symptoms. The positioning of the hand and arm for bareback riding produces rapid eccentric torque on the ulna.[11] This repetitive unilateral overload is thought to cause ulnar thickening in bareback riders.

As a result of their analysis of abnormalities in the upper extremities of rodeo athletes, Meyers et al.[11] concluded that bracing should be encouraged in rodeo competitions as it could potentially reduce the chronic strain associated with this sport. Prospective studies are needed to evaluate the efficacy of preventive measures reducing radiographic signs of hypertrophy as well as clinical indications of persisting pain.

Future studies are needed to determine the correlation of increased bone and soft tissue hypertrophy with nerve pain. Nerve conduction tests in the arms of rodeo athletes should be run, given the abnormal results from nerve conduction tests of the radial and ulnar nerve in the dominant arm of tennis and hockey players.[6,17] Abnormal ulnar nerve conduction was found at the elbow of volleyball players as a result of strenuous elbow movements, potentially suggesting subclinical entrapment neuropathy.[18] Conti et al.[5] also found that the ulnar nerve is strained during periods of extreme valgus stress at the elbow for overhead throwing athletes. Twisting and stretching of the arm caused by the pulling of a bucking animal could be related to the unilateral pain that we are observing in rodeo athletes. Bone mineral content, total area, and cortical area should also be measured to allow for more direct comparisons across different sports and pre-existing studies.

Conclusion

The results of this study suggest that increased load on the grip arm of bareback rodeo athletes may result in bony hypertrophy. Given the high stress placed on the grip arm, significant anatomic changes are occurring that may be contributing to persistent pain in these patients. These changes should be taken into account when evaluating these athletes and making clinical judgements concerning their course of treatment.

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Ethical approval

Ethical approval for this study was waived by Justin Sports Medicine as no study specific tests or interventions were performed and no identifying data was used in this report. The approval number is JSM-17001.

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Informed consent

Verbal informed consent was obtained from all subjects before the study. Written informed consent was waived by Justin Sports Medicine Ethics Committee as no study specific tests or interventions were performed and no identifying data was used in this report.

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