TRANSIENT BONE LOSS OF DISTAL RADIUS AND ULNA FOLLOWING CLEAN-CUT TENDON INJURIES, REPAIR AND PASSIVE MOBILISATION

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The aim of this study was to investigate whether there is any significant bone loss of the ulna and radius following acute tendon-artery-nerve clean-cut injuries at the wrist level which were repaired and rehabilitated by early passive mobilisation. Fifty-eight patients who underwent such operation were enrolled in this study. Patients in Group I ($n = 28$) had primary tendon repairs alone, in Group II ($n = 15$) primary tendon and nerve repairs and in Group III ($n = 15$) primary tendon, nerve and artery repairs. Bone mineral density (BMD) measurements of the ulna and radius were obtained during the first week, the sixth week, the third month and the 12th month after operation. The results demonstrated that BMD decrease in the ulna was more common than in the radius. When compared with the first week BMD measurements, the highest reduction was seen in the sixth week in Group I and during the third month, when bone loss of both the radius and ulna was considerable in Group II. The bone loss in all groups and subgroups were found to have recovered at the 12th month measurements, except in the distal region of the ulna in Group I. This study suggests that passive immobilisation is deleterious in respect of demineralisation of the forearm bones.

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Disuse osteoporosis is a localized, or generalized, bone loss due to the reduction of mechanical stress on bones. Reduction, or loss, of mechanical stress on bones induces acceleration of osteoclast-mediated bone resorption and inhibition of osteoblast-mediated bone formation, leading to bone loss. Localised osteoporosis is commonly encountered in patients with immobilisation due to the application of casts for the treatment of tendon or ligament injuries (Ditsios et al., 2003; Leppala et al., 1999; Silva et al., 2002; Weinreb et al., 1997). Tendon lacerations of the distal forearm are common, usually multiple and the injury often involves nerves and vessels (Schneider and Hunter, 1993). Primary repair and early mobilisation, passive or active, in protective splints over several months are the customary manner of treatment.

In this study, we analysed the bone mineral density (BMD) changes in the radius and ulna in patients with acute injuries of the flexor aspect of the wrist who were treated by early primary repair and passive tendon mobilisation.

PATIENTS AND METHODS

Fifty-eight patients, including 13 females and 45 males of mean age 31.8 ± 12.3 (range 14–67) years were enrolled in this study over a period from November 2002 to December 2004.

Informed consent was obtained from all of the patients. The study was approved by the ethical committee of the Inonu University Faculty of Medicine and was conducted in accordance with the Helsinki Declaration.

All patients presented acutely with clean-cut injuries of the flexor aspect of the wrist. According to the operative findings, the patients were split into three groups, determined by the structures divided. Patients in Group I, including six females and 22 males of mean age 30.8 ± 11.2 (range 14 to -53) years, underwent tendon repairs only (65 tendons in toto with an average of 2.32 (range 1–5) tendons per patient). Group II, including four females and 11 males of mean age 31.1 ± 11.3 (range 15–50) years, underwent tendon and nerve repairs (48 tendons in toto with an average of 3.2 (range 1–5) tendons and one nerve injury per patient). Group III, including three females and 12 males of mean age 34.5 ± 15.4 (range 15–67 years), underwent tendon, nerve and artery repairs (115 tendons in toto with an average of 7.66 (range 3–12) tendons per patient). This group also had 26 nerve injuries in toto with an average of 1.73 (range 1–3) nerves per patient and 22 arterial injuries in toto, with an average of 1.47 (range 1–2) arterial injuries per patient).

After surgery, the injured limbs were immobilised in long arm cast for 4 weeks and short arm cast for a further 2 weeks. Patients were educated to do passive mobilisation exercises according to the Duran technique in the long arm cast after the fourth postoperative day in Group I and after the third postoperative week in Groups II and III. These passive mobilisation exercises were carried out by the patients alone after surgeon instruction. The casts were removed at 6 weeks and all patients then started active mobilisation exercises with physiotherapists.

None of the patients had any previous forearm fracture, skeletal disease or serious intercurrent disease and none had used any drugs known to affect bone metabolism, e.g. oestrogens, glucocorticosteroids, anticonvulsants, vitamin D or calcium supplements. Osteoporotic patients who had T scores less than −2.5 in total lumbar DEXA measurement were not included in this study.

The BMD of the injured forearms was measured with dual-energy X-ray absorptiometry (QDR 4500/W, Hologic Inc., Bedford, MA, USA). This is currently the most commonly used tool for the measurement of bone mineral content because of its accuracy, precision, stability and low dose of radiation, as well as the speed and ease of scanning (Jarvinen and Kannus, 1997). The results were all evaluated by one examiner. Three neighbouring subregions (proximal, middle and ultra-distal) were identified using the forearm subregion analysis software of this manufacturer. Proximal, middle and ultra-distal regions were redefined anatomically as the mid-diaphyseal, distal and ultra-distal regions of the radius and ulna for the purpose of this study (Fig 1).

Bone mineral measurements of the injured forearms were performed during the first week ($n = 58$), the sixth week ($n = 53$), the third month ($n = 46$) and the 12th month ($n = 52$) after surgery.

The decrease rate of BMD of the three subregions of the radius and ulna were calculated using the formula – BMD decrease rate = $[(BMD_{\text{first week}} - BMD_{\text{after}})/BMD_{\text{first week}}] \times 100$ (Xiaoge et al., 2000).

Normal distribution of groups was not found with a Shapiro–Wilk test. Comparison of the groups was, therefore, evaluated with a Friedman test and Wilcoxon signed-rank test. All statistical analyses were performed with SPSS for Windows version 13.0. Because of the Bonferroni correction, $P < 0.02$ was considered as statistically significant.

Fig 1 The regions of the ulna and radius on forearm densitometry (UD = ultra-distal; D = distal; MD = mid-diaphyseal).

RESULTS

The bone mineral density measurements of the groups are presented in Table 1.

In Group I, The BMD measurements were diminished significantly over time in the distal and ultra-distal regions of the ulna with a decrease rate of 3.32% and 6.04%, respectively ($P = 0.001$ and 0.001, respectively). Measurements in the other subregions of the radius and ulna in Group I showed no significant BMD decreases. Most of the reduction in Group I occurred in the sixth week (Fig 2). BMD values in the distal regions of the ulna were significantly different between the first week and the 12th month in Group I ($P < 0.02$) but BMD values in the ultra-distal region of the ulna were not ($P > 0.05$).

In Group II, the BMD measurements were diminished significantly over time in the distal and ultra-distal regions of the ulna and in the ultra-distal region of the radius with a decrease rate of 8.16%, 11.5% and 6.18%, respectively ($P < 0.02$, $P < 0.02$ and $P = 0.03$, respectively). Measurements in the other subregions of the radius and ulna in Group II showed no significant BMD decreases. Most of this reduction occurred between the sixth week and the third month (Fig 3). BMD values in Group II were not statistically different between the first week and 12th month ($P > 0.05$) (Table 2).

The BMD of the radius and ulna did not change significantly over time in Group III ($P > 0.05$) in any of the subregions of the radius or ulna. The patients in Group III, with arterial injuries were examined for arterial patencies in the 12th month by Doppler Ultrasound and all found to be sufficient.