INTRODUCTION:

Four corner midcarpal fusion (fusion of the lunate, capitate, triquetrum, and hamate) is a common procedure for scapholunate advanced collapse (SLAC) wrist arthritis, midcarpal instability, and lunotriquetral dissociation. Previous studies 1-3 examined the influence in motion between inclusion and exclusion of scaphoid; however, the effect of scaphoid excision on ultimate motion or the radiolunate contact pressure was not investigated. The effect of excision of the triquetrum on these variables was also not studied.

The purpose of this study is to evaluate wrist motion and radiolunate contact characteristics (as an indicator of potential predisposition for cartilage overload) in-vitro after simulated midcarpal fusion. The range of motion (ROM) of the wrist, and radiolunate contact area and pressure was measured for the intact specimen (IS), 4 corner fusion with a spider plate (Scaphoid Retained (SR), scaphoid inclusion using Acutrack screws (SI), scaphoid excision (SE), and triquetral excision (3 Corner Fusion) (TE).

METHODS:

Six normal fresh frozen cadaver specimens with no pre-existing ligament damage were used in this study. Muscles and tendons were removed and middle digit and thumb were disarticulated at metacarpo-phalangeal joint (MPJ). The dorsal capsule and intra-articular ligaments were spared.

Custom jigs were made to hold the specimen in upright position and 44 N loading was applied on the middle digit through Steinmann pin. Ultra low Fuji prescale pressure sensitive film (Sensor Product Inc. Frederick, Maryland) was calibrated at controlled temperature and humidity to measure the contact pressure and area of radiolunate joint. The contact pressure print was processed by Image software (Scion Inc., East Hanover, NJ) to measure the contact pressure and area of radiolunate joint. The dorsal capsule and intra-articular ligaments were spared.

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RESULTS:

Figure 1 shows the change in ROM for different procedures. The percentage of change for every procedure is shown in Table 1. For the 4 corner fusion, flexion (FL) was unchanged (p>0.05), but extension (EX), radial deviation (RD) and ulnar deviation (UD) increased (p=0.002, 0.009, 0.002). For scaphoid inclusion, flexion and radial deviation were not affected (p>0.05), but extension and ulnar deviation were reduced (p=0.03, 0.008). For scaphoid excision, flexion, extension, and ulnar deviation were unchanged (p>0.05), but radial deviation was increased by 107% (p=0.003). For triquetral excision, flexion was unchanged (p>0.05), however extension, radial deviation, ulnar deviation were increased (p=0.02, 0.003, 0.0004). In summary, flexion was unaffected by these procedures. However, scaphoid excision resulted in greater motion than retention, and triquetral excision resulted in even greater extension radial deviation and ulnar deviation.

Figure 1. ROM under different procedures.

Figure 2 shows radiolunate contact area, mean pressure of contact area and maximal pressure under different procedures comparing to IS.

Table 1. Percentage change of ROM under different procedures.

Table 2. The percentage change of contact area, mean pressure and maximal pressure under different procedures comparing to IS.

DISCUSSION:

Scaphoid inclusion decreased ROM without decreasing radiolunate contact force, thus providing no apparent benefit. Scaphoid excision improved ROM compared with retention for all planes of motion. There was no significant change in radiolunate contact pressures. Thus, scaphoid excision should probably be considered even if scaphoid retention is acceptable (i.e., for midcarpal instability, and lunotriquetral dissociation). Triquetral excision (3 Corner Fusion) further improved ROM significantly, without significant change in contact pressure and area. This might be due to an artifact from radiolunate joint translation.

The results of contact pressure showed no significant change throughout all stages. This may be explained by the congruity of the hemispherical radiolunate articular surface; as contact forces rise, contact area increases to keep contact pressures relatively constant. Therefore, clinicians may consider choosing midcarpal fusion technique based on ROM, as radiolunate contact pressures and assumed potential for future cartilage breakdown via joint overloading demonstrate no significant differences. In summary, this study suggests that scaphoid excision retains greater ROM following 4 corner fusion, compared to inclusion or retention, and that triquetral excision (3 corner fusion) retains even greater ROM.

REFERENCES: