INTRODUCTION:
Rotator cuff tears are a common cause of shoulder pain and disability. Surgical repair of the rotator cuff tears is effective for improvement of shoulder function. The long head of the biceps brachii (LHB) tendon has an important mechanism for humeral head stability and glenohumeral articulation. Several lesions around the LHB tendon associated with rotator cuff tears are reported in the literature such as SLAP lesions and rotator interval lesions. Optimal treatments for the underlying pathology around the LHB tendon with rotator cuff tears are crucial for improvement of normal shoulder function. However, functional changes of the LHB tendon with rotator cuff tears are not well known though they present various pathological changes. Functional changes could be analysed by the morphological changes by various imaging procedures. Magnetic resonance arthrography (MRA), which employs intra-articular injection of a dilute solution of gadolinium before MRI, has significantly improved visualization of the intra-articular structures and abnormalities of the shoulder. The purpose of this study is to assess morphology and localization of the LHB tendons with rotator cuff tears with MRA to evaluate functional changes of the LHB tendons.

MATERIALS AND METHODS:
We retrospectively evaluated MRA of 47 shoulders in 46 patients with surgically treated full thickness rotator cuff tears. Subjects included 22 men and 24 women, with a mean age of 61.9 years (range, 41 to 77). All full-thickness tear sizes were measured transversely and longitudinally with a ruler at surgery. We classified three groups according to the maximum rotator cuff tear sizes. S group (small size tear / below 10mm): 10 shoulders. M group (Middle size tear / between 10 and 30 mm): 23 shoulders. L group (Large size tear / above 30 mm): 14 shoulders. 8 shoulders in 8 people without rotator cuff tear (N group) were used as control. Their mean age was 29.6 years old (range, 20 to 40). The shoulder was positioned in neutral position with the humerus in neutral rotation, and MR images were obtained.

Morphology and localization of the LHB tendon were evaluated with oblique sagittal images in the 4mm lateral plane parallel to the glenoid fossa (Fig. 1). The MR images were scanned into a personal computer and analyzed by image-analyzing software (NIH Image). We measured three parameters: LHBw: the width of the LHB, LHBt: the thickness of the LHB and LHBa: anterior displacement angle of the LHB which was the angle determined by the humeral shaft axis and the LHB-humeral head axis (Fig. 2). We analysed three parameters in four groups (N, S, M and L). Statistical analyses were performed using one-factor ANOVA. Significance was set at the 5% level.

RESULTS:
The average measurements of N, S, M and L was 9.60, 9.60, 10.42 and 12.22 respectively in LHBw; 2.10, 2.93, 3.49 and 4.20 respectively in LHBt; 15.78, 17.52, 20.94 and 25.36 respectively in LHBa (Fig. 3). LHBw and LHBt in L group were significantly larger than those in S and M groups (p=0.039 and p=0.014 respectively in LHBw, p=0.029 and p=0.037 respectively in LHBt). LHBa in L group were significantly larger than those in S group (p=0.0474).

DISCUSSIONS:
The results of this study revealed two important observations. First, the size of rotator cuff tear became larger, the width and thickness of LHB tendon became larger. Second, LHB tendons were displaced more anteriorly with increase of rotator cuff tear size. Morphological changes of the LHB tendons implied that mechanical stress to the LHB tendons were increased with enlargement of the rotator cuff tear size. Antero-superior displacement of the humeral head with rotator cuff dysfunctions might be one of the reasons to make mechanical stress to the LHB tendons. In those situations, the LHB tendons might be forced to work as substitution of the damaged rotator cuff tendons. Anterior displacement of the LHB tendon implied that impairment of the lateral coraco-humeral ligament, important for LHB tendons’ stability, were occurred with rotator cuff tears (Fig. 4). Dysfunction of this ligament could make anterior displacement of the LHB tendons and lose their function as a depressor of the humeral head. This might be one of the reasons of the anterior shoulder pain and its instability could eventually increase the Subscapularis tendon damage. These changes in morphology and localization of the LHB tendons with rotator cuff tears are extremely important information for the optimal treatments of the LHB tendons during rotator cuff repair surgeries.

CONCLUSION:
The width and thickness of LHB tendons increased with the increase of rotator cuff tear size; the LHB tendons were displaced more anteriorly in the same manner.