1	Title: Novel stress tests for diagnosing Little League shoulder, and determining the timing of return
2	to sports
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14	Abstract
15	Background: The primary etiology of Little League shoulder (LLS) is rotational torque caused by
16	repetitive throwing motion. However, there are few reports on the assessment of rotational torque
17	during physical examinations.
18	Purpose: To investigate the usefulness of the resisted external rotation test (RERT) and the resisted
19	internal rotation test (RIRT) in diagnosing LLS and determining the time to return to sports (RTS).
20	Study Design: Case series; Level of evidence, 4
21	Methods: In total, 101 patients were diagnosed with LLS by proximal humeral physeal widening on
22	radiography and tenderness upon palpation over the lateral aspect of the proximal humerus, and the
23	RERT and the RIRT were performed. During the two tests, the examiner lifted the patient's elbow
24	joint with one hand toward the humeral shaft and held the patient's wrist joint with the other hand. In
25	the RERT/RIRT, the patient was instructed to apply a maximum force of external/internal rotation

from neutral alignment. The examiner resisted the force of external/internal rotation and maintained the setting position while holding the wrist joint. These test results were positive if either or both tests elicited shoulder pain. Positive test results and their association with radiographic findings were examined. In case of positive test results, the time to achieve negative test results and the time to RTS were investigated.

Results: The RERT/RIRT were correlated with severity of LLS. The sensitivity of RERT/RIRT for LLS was 94.1/36.6%. In RIRT, patients with advanced-stage LLS were more likely to have positive results than those with early-stage LLS (67.4% vs 10.9%, P < 0.001). The average time to achieve negative RERT and RIRT results were 6.7 and 4.7 weeks, respectively (P = 0.012). Patients with

advanced-stage LLS had a longer average time to achieve negative RERT results than those with

early-stage LLS (6.7 vs 4.7, P < 0.001). The times to RTS were 8.8 weeks in the group who resumed

37 throwing after achieving negative RERT, while the group that resumed throwing before RERT

became negative took 12.7 weeks (P < 0.001).

39 Conclusions: The RERT may be useful in determining the presence of LLS and when RTS can be40 allowed.

41 Keywords: shoulder; baseball; Little League shoulder; stress test; diagnosis; return to sports