



# Static-Stress MRI for Evaluation of Complex Pulley-Lesions of the Finger in Sports Climbers

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## Abstract

**Problem:** Pulley-lesions of the fingers are typical injuries in climbing sports. In general, a rupture of the A2-pulley is found, without significant medical impact. Complex pulley-lesions may be devastating for a high-level career in sports climbing. Standard MRI in stretched finger position is not able to evaluate the A3-pulley, which is crucial for graduation of complex pulley lesions.

**Methods:** We introduce stress MRI in a flexed finger position. This allows quantification of the distance between the palmar plate and the deep flexor tendon (A3-distance).

**Results:** According to our data following MRI-examinations of 24 high-level sports climbers an A3-distance of 4 mm or more indicates rupture. An A3-distance up to 1 mm seems to be normal in high-level sports climber. However, due to the small sample number we did not find a clear cut-off point between strain and rupture.

**Discussion:** The rather small and elastic A3-pulley defines the complexity of pulley-lesions. Conservative treatment is preferable if there is still continuity of the A3-pulley. Beside diagnostic imaging, Stress MRI of the fingers give some functional information about an injured A3-pulley in addition.

**Conclusion:** Stress MRI of the fingers is an easy to perform tool for evaluation of the A3-pulley in every MRI-scanner available.

## Introduction

The typical injury of the finger in climbing sports is a lesion of the A2-pulley [1-3]. The degree of such a lesion can be determined by diagnostic imaging such as ultrasound and MRI [4-7]. Tenophalangeal hematoma, discontinuity of the pulley itself and tilting of the flexor tendon are well known signs of traumatic pulley lesions. In most cases, this is neither a medical nor an athletic problem. Complex pulley-lesions including the A2 to A4-pulley, causing a clinical condition called bowstringing, represent a possible indication for surgery. Standard MRI of the finger is performed in an extended position. However, this means that the A3-pulley is hard to assess. When the A2 and A4-pulleys are ruptured, one might assume that the rather small and elastic A3-pulley must be ruptured as well. But is this true (Figure: 1)? There are only a few reports on MRI of the finger in flexion [8,9]. We investigated stress MRI of the fingers for better assessment of the A3-pulley.

## Methods

23 consecutive, high-level sports climbers (female: 6, male:

17; age: 28.4 years, range: 17 - 54 years; Tab.: 1) with a suspected pulley lesion, received standard MRI of the finger followed by an additional stress MRI. In a superman position, the climbers were asked to fix a syringe between their thumb and the injured finger (Figure 2). Sagittal images in T2-weighted images with additional fat-suppression were performed. Using the PACS-integrated measurement tool, the A3-distance was quantified. We defined the A3-distance as the largest distance between the palmar plate and the deep flexor tendon perpendicular to the palmar plate (Figure 3).

## Results

Due to motion artifacts one data set had to be excluded. In cases without proven pulley lesions, the average A3-distance was 0.4 mm (range: 0 - 1 mm). For single pulley-lesions, the A3-distance averaged 0.53 mm (range: 0 - 1.2 mm). When two pulleys were injured the mean A3-distance was 1.82 mm (range: 1.2 - 2.3 mm). In two cases of clinical proven bowstringing the A3-distance was 4 mm each (Table 1). All pulley lesions detected were treated conservatively. One of the two cases with bowstringing, was lost during the further follow-up. All other climbers with proven pulley lesion regained their prior performance level within 9 months.

## Discussion

Knowledge of the integrity of the A3-pulley is crucial for graduation of complex pulley lesions. Even in situations of rupture of the A2 and A4-pulley, the A3-pulley might be strained but not ruptured. This allows climbers to regain competitive strength within 6 months' time. This was demonstrated well by one case from our series, where the A3 distance was 2.1 mm at 4 weeks following the trauma. Due to the clinical presentation, we proposed conservative treatment. At 12 weeks following trauma,

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	pulley-lesion		A3-distance				
	A2	A4	mm				
♂ '74	+	+	4	bow-stringing			
♂ '66	+	+					
♂ '90	+	+	2	1.82	0.93		
♂ '90	+	+	2.3				
♂ '69	+	+	1.8				
♂ '95	+	+	1.2				
♀ '00	+		0				
♂ '77	+		1.2	0.53			
♂ '05	+		1.1				
♀ '02	+		1.2				
♀ '94	+		0				
♂ '00	+		0				
♀ '03	+		0.7				
♂ '85	+		0				
♂ '92		+	0.6				
♂ '94			1			0.4	
♂ '92			0.8				
♀ '02			0				
♂ '92			1				
♂ '90			0				
♂ '93			0				
♂ '03			0				
♀ '97				excluded			

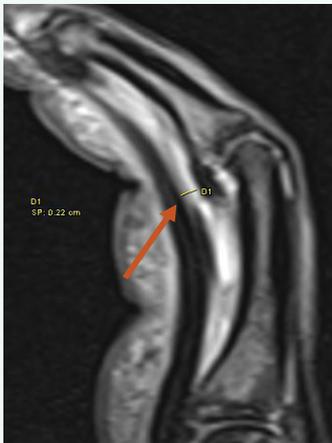
**Table 1** Patient data and results.



**Figure 1** (A) Sagittal T2-weighted MRI following rupture of the A2 and A4-pulley with edema and hematoma in the tenophalangeal space. (B) Stress- MRI of the same person disclosed an A3-distance of 2.2 mm. Together with the clinical symptoms, this was considered to be a strain. (C) Bowstringing in a different case with an A3-distance of 4 mm.



**Figure 2** Patients were asked to fix a syringe between their thumb and the injured finger during the MRI-examination.



**Figure 3** Sagittal, PD-weighted MRI of the finger demonstrating measurement of the A3-distance, which represents the largest, perpendicular distance between the palmar plate and the deep flexor tendon.

the A3-distance was 2.3 mm. However, the clinical symptoms clearly improved, and the patient told us, that in his perception the force he was able to execute was much higher than before. 6 months following the trauma, high-level sports climbing was possible again. A 3<sup>rd</sup> MRI disclosed an A3-distance of 2.2 mm. We believe that fibrous remodeling of the A3-pulley leads to sturdiness with loss of elasticity. However, it is still a debate whether conservative treatment is reasonable in complex pulley-lesions if climbers are still able to bend the injured finger almost completely [1-3,10].

Our data exclusively refer to high-level sports climber. An A3-distance of 4 mm and mores indicate rupture with consecutive

bowstringing. An A3-distance up to 1 mm seems to be normal. Due to the small sample number of our study, we were not able to define a clear cut-off point between strain und rupture.

It is very likely, that higher field strengths of MR-scanners will allow direct evaluation of the pulley ligaments in the future [11,12]. Currently, stress MRI provides a feasible method for better evaluation of the A3-pulley in any kind of MR-scanner. It is an additional examination and should only be used in specific situations. We strongly believe, it is an important tool to better understand complex pulley lesions. This should be known not only by radiologists but also by hand surgeon and responsible persons in sport climbing.

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