

## A POTENTIAL CLASSIFICATION SCHEMA AND MANAGEMENT APPROACH FOR INDIVIDUALS WITH A2 FLEXOR PULLEY STRAIN

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Finger pulley injuries are a rare occurrence in the general public, but are a frequent injury to rock climbers (3,9). Injury to the annular ligaments is the most common injury in rock climbers due to climbers heavy reliance on finger strength (2,8,12,13). Rock climbing, historically a niche sport, has become more mainstream as evidenced by its inclusion in the 2020 summer Olympics in Tokyo, Japan (4). In parallel with the sports increasing popularity we hypothesize the incidence of non-traumatic annular pulley strain will also increase.

The conservative treatment of individuals with flexor tendon pulley strains and/or ruptures has not yet been fully established. Choosing an appropriate therapeutic management plan for these individuals is difficult due to poorly characterized levels of severity of injury to the pulley(s). The objective of this article is to fill this gap and classify strains into subcategories of severity that aim to guide therapeutic pathways. Current research suggests that conservative therapy is recommended for isolated pulley strains and single pulley ruptures (Schoffl Grade 1-3) while multiple pulley ruptures require surgical reconstruction (Schoffl Grade 4). (8,13) Conservative treatment options range from complete rest, ice and splinting (5) to taping at the base of the finger (7) and functional therapy. The proposed therapeutic management model is first based on a clinically pragmatic classification schema designed to help therapists distinguish between individuals that would benefit from treatments optimizing rest and immobilization from those that would benefit from approaches incorporating restorative resistance and return to sport exercises.

### Hand Grip Positions Commonly Used While Climbing

The Crimp grip position is used by 90% of climbers (2) and is one that requires the climber to flex the proximal interphalangeal joints (PIP) 90-100 degrees maintaining pressure at the distal phalanx while the distal interphalangeal joints (DIP) are in 0-10 degrees extension. (2) (Fig 1) The smaller the hold, the more force is generated by the flexor digitorum superficialis (FDS) (1,15) and the pressure at the A2 pulley increases to a level causing possible pulley strain and rupture. (11).

Figure 1



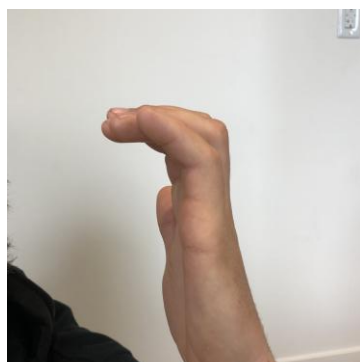
The Sloped grip position is often used to grip smaller holds and sloping features (aka “slopers”). The DIP joints are flexed maximally while the PIP joints are between 30 degrees flexion and 0 degrees extension. (15). The sloped grip position is the safest position for the A2 pulley relative to the crimp grip position (Fig 1) and the half crimp grip position (Fig 3) described below. (6, 15)

Figure 2



The Half Crimp grip position is characterized by relative extension of the metacarpal phalangeal (MCP) joints while the PIP joints are in approximately 90 degrees of flexion and DIP joints are in slight flexion. (Figure 3) Many climbers train this position for improving finger strength and it is therefore a functional position to test a climber in.

Figure 3



#### Classification Schema: Description of Signs and Symptoms

1. Pain: Using a numeric scale (VAS) of 0-10 (0=no pain 5=I want to take something for my pain and 10=worst possible pain), have the patient rate his or her pain at rest, with light activity, and with work/sport activity.
2. Active Range of Motion (AROM) is observed with patient starting with fingers in full extension. Patient then starts by flexing the DIP joint to initiate flexion AROM. Patient tries to bend through each sequential joint until a crimp grip position is reached. It is unnecessary to move all the way into a closed fist position but rather stop when the DIP and PIP are in full flexion and begin to flex the MCP joint. This position is equal to a closed crimp grip position without the thumb. Patient then reverses the motion and attempts to extend the fingers fully.
3. Resisted Tests: Test the individual flexor muscles of the hand and the integrity of the A2 pulley by using the above described grip positions. The first to be tested is the sloped grip position whereby the examiner can hold the PIP and MCP joint in relative extension and apply direct resistive pressure to the DIP volar pad. (Fig.4) The second position to be tested is the Half Crimp position measuring a combination of FDP and FDS with resistive pressure along IP and DIP volar pad (Fig. 5). Full Crimp position is used for full activation of FDS and FDP again with resistive pressure at the DIP volar pad (Fig. 6) and is the position where most A2 pulley ruptures occur.

Figure 4



Figure 5



Figure 6



4. Palpation: Palpation is limited to the area directly over the A2 pulley. Palpation is measured by the amount of direct pressure the therapist can apply before pain is elicited. The amount of blanching present in the examining therapist's fingertip bed serves as a method for quantifying this measurement. Starting with minimal pressure and stopping when the palpation elicits pain. A classification of severe will elicit pain with little pressure applied and therefore no blanching in the examiners nail bed will be observed while a classification of mild will elicit little to no pain with the examiner observing significant blanching in the nail bed.
  - a. Minimal pressure (no blanching)
  - b. Moderate pressure (mild blanching of the examiner's digit)
  - c. Firm pressure (full blanching of the examiners digit)

Signs and  
Symptoms

Severe Stage

Moderate Stage

Mild Stage

Pain	Rest: Limits activities of daily living ( $\geq 5$ VAS)  Active: Severely limits climbing ( $> 5$ VAS)	Rest: Min-Moderate pain (3-5 VAS) with activities of daily living  Active: Moderate-Severe ( $\geq 5$ VAS) Pain that limits climbing in all grip positions	Rest: No pain (0 VAS)  Active: Minimal pain (0-2 VAS) after climbing. Mild to Moderate pain (2-5 VAS) with full crimp grip No pain with Sloped grip
AROM	Pain and $>50\%$ limited ROM compared to unaffected side with finger flexion-extension range of motion	Pain at end range finger flexion with $\leq 25\%$ ROM loss	No pain or ROM loss with AROM (Some pain possible if patient squeezes at end range flexion/crimp.)
Resisted Tests	Pain and weakness with any resisted Flexor muscle MMT or "Grip" Hand position	Sloper= minimal pain  Half Crimp= minimal-moderate pain  Full crimp= moderate-severe pain	Sloper= No pain  Half Crimp= zero-minimal pain  Full Crimp= zero-minimal pain
Palpation	Pain with pressure directly along A2 pulleys with no blanching of fingers (minimal pressure)	Pain with palpation of A2 region with mild blanching of examiner's fingers (moderate pressure)	Minimal to no pain at site of A2 pulley specific with firm pressure from examiner's fingers (full blanching)

The proposed application of the classification schema is to stratify individuals according to stage of severity with A2 pulley strains and classify them as "severe"; when treatment might best consist of rest and immobilization, gentle range of motion and profound activity modification. In contrast, individuals characterized as being at a "mild" stage might benefit most from a restorative exercise program that incorporates progressive resistance and hang board training. Individuals in the "moderate" stage might be suited for a lower intensity program. Over the course of time it is assumed that an individual will "progress" (or "regress") from one stage to the next and treatment/management approaches should be adapted accordingly. For example, an individual in the "severe" stage may over a period of weeks progress in their ability to perform range of motion and light resistance without pain and therefore be re-classified into the "moderate" stage. However, it is also possible for an individual to regress from a "moderate" to a "severe" category if exercise prescription is overdosed and the management plan is not tolerated well. This classification schema also allows therapists to determine the efficacy of a particular treatment or approach on the rate of healing. Communication within treatment teams is made easier by clearly defining the stage of healing and therapists are able to adjust the treatment plan to optimize healing time.

Ultimately, the utility of this classification schema and general management plan will be dependent on its incorporation into a clinical trial and its assimilation into clinical tests and measures. In effect, leading to more targeted therapies to optimize healing times and activity levels in those suffering from A2 pulley strains.

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