# Objective Mobility in Idiopathic Adolescent Scoliosis: A How-To on Objectifying Function to Facilitate Management Decisions

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## Abstract

Adolescent idiopathic scoliosis (AIS) is a common disease managed by pediatric orthopedic physicians. Current management is limited in objective measures, the mainstay being static radiographic evaluation of the Cobb angle. In this short commentary, we propose the use of video analysis software (VAS), specifically Dartfish Prosuite, to improve objectivity through quantified kinematic data (i.e. gross and segmental spinal motion and compensatory motion patterns), permitting clinicians to monitor gradual progress pre- and post-intervention. Further studies and larger databases will lead to better evidence-based guidelines to inform physicians' decision making process for AIS, including operative spinal fusion.

## Introduction

Adolescent idiopathic scoliosis (AIS) is the single most common form of spinal deformity in pediatric orthopedics, affecting between 2-4% of the adolescent population between 10 and 16 years of age [1,2]. Currently, there are three primary categorical approaches to AIS management, falling along a progressive continuum of exercising, bracing and surgical fusion. It has been noted that patients are often advanced to more invasive interventions without giving conservative management the opportunity to have an effect [3]. Radiographs have been the mainstay for treatment guidelines and are necessary for the decision to undergo surgery, but these are only static representations of deformity. In fact, we have noted anecdotally that the mobility of the spinal curvature (based on dynamic radiographs) or length of spinal fusion does not always correlate with the patient's spinal range of motion (ROM) and function. Questionnaires aid in the overall assessment of the patient [4], but these are subjective. The clinician would benefit from objective data to define the patient's overall function. We propose that video analysis software (VAS) can help guide the clinician.

## Video Analysis Software

One innovative and economically viable solution that some clinicians have started to implement in their clinical practices and research protocols is video analysis software (VAS) to objectify spinal mobility and function pre- and post-intervention [5-8]. VAS is a two-dimensional (2-D) kinematic and gait analysis tool that leverages webcams and post-hoc video-image processing for objective mobility metrics. Some systems combine mobile platforms into the video acquisition process, including smart phones and tablets [9]. This has ultimately lowered the barrier to client adoption by reducing cost and improving feasibility in an office setting. There are many VAS products on the market today. One of these 2-D, video based analysis software platforms is the Dartfish ProSuite. Dartfish has been implemented by athletic training centers to refine form and technique

over the last decade. To this end, this innovative 2-D motion technology has not been evaluated in objectifying spine motion; however the system has been proven to be accurate with simple motions [10-12].

## Deformity Management

As previously described, physicians rely on a subjective evaluation along with X-rays for determining management options. Doctors typically begin to intervene with physical therapy as the AIS curve progresses past 20 degrees [13]. Bracing is usually added to physical therapy for curves greater than 30 degrees, and surgical fusion is considered as the last step in management for primary curves above 40 degrees [13,14]. Other factors can mitigate management, but the overall algorithm relies heavily on radiographs. The objective data garnered from kinematics testing under VAS will make the decision process easier, especially for patients who straddle the cutoffs for next level management.

## Deformity and Pain

Although cosmetic deformity is the major complaint, some patients with AIS experience pain. Although most practitioners agree that the pain caused by AIS usually does not disable patients and they are able to live full, productive lives [15,16], it presents a clinical challenge as it is unclear whether surgical intervention helps alleviate the symptoms. One long-term, 20-year prospective study did not find a difference in quality of life and functional status between AIS patients who had undergone a surgical fusion and those treated conservatively [17], but these were based mostly on questionnaires. As motion is often affected by pain, VAS may provide a help objective indicator to define the difference between operative and non-operative management.

## Deformity and Motion

The objective for all AIS management is to correct the underlying deformity, prevent curve progression, and preserve motion segments

[18,19]. Additionally, when pertaining to surgical fusion, motion segment preservation or limiting the number of fused segments preserves growth potential and distributes the motion in the unfused regions across more segments. While there is some understanding of the effects of fusion on local and segmental motion, such as the effect of level choice on distal compensatory motion [20], there is limited data on the overall effect of fusion on gait kinematics, motion of the spine during functional tasks, and trunk mobility. Kinematic data collected through motion capture technology will enhance our understanding of quantitative spinal ROM, compensatory movement patterns and overall function.

Standardizing VAS acquisition could lead to generation of a large database of motion measurements. Researchers and clinicians together can then better understand how deformity affects function with large-scale analyses focused on outcomes. Clinicians can follow patients longitudinally, pre-intervention through post-intervention and throughout the course of disease, including remission, progression or exacerbation.

## Conclusion

VAS is a specific type of motion capture technology that can enhance the clinician's appreciation of how deformity affects clinical function with objective data. This will ultimately promote well-informed decision-making, guide patient expectations, and optimize patient outcomes with less costly and invasive interventions

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