THE IDENTIFICATION OF RELEASE ON THE HORIZONTAL BAR

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A horizontal bar routine in Men's Artistic Gymnastics is characterized by swinging around the bar and by flight elements such as release-regrasp skills and dismounts. These dismounts are often skills in which a gymnast performs multiple somersaults and twists while reaching heights in excess of 4 meters above the landing surface (Kerwin *et al*, 1990). The importance of these elements in a horizontal bar routine has been the impetus for considerable sport biomechanics research. The study of these skills has been predominately of two types, analysis of elite performers, and simulation and prediction based on these analyses. Although the gymnast cannot be modelled as a point mass or a single rigid body, the gymnast is indeed a projectile and thus the flight component of these skills are largely determined at the instant of release. The release parameters are the primary inputs into any predictive simulations of these skills.

Cinematography has been used almost exclusively to collect data on dismounts and release-regrasp skills as performed by gymnasts on the horizontal bar. Traditionally the release has been defined as the first instant (or frame of film) in which the gymnast is seen to have broken contact with the bar (Kerwin *et al*, 1990). Harwood submitted, that crucial to the analysis of these skills is the definition and identitication of **release** since "an error of one frame makes a large difference to the body position and relative contributions to velocity" (Harwood *et al*, 1991, p74). Harwood defined release as the first instant when the wrist started moving away from the bar. Using this definition and the identical film records of 4 performances of triple back somersault dismounts that Kerwin *et al* (1990) had used, Harwood found that all the gymnasts released below the level of the bar whereas Kerwin had found that they all released above the level of the bar. The traditional definition does provide for a very distinct point in time usually easily identifiable from film records whereas Harwood's definition is dependent on being able to precisely locate both the bar and wrist. Given that the image size is often small considering that the field of view is usually greater than 8 meters, identification of these two points are subject to errors in both precision as well as accuracy. This may be further complicated by the fact that gymnasts wear hand guards which do not permit full extension of the fingers thus obscuring the location of the bar and the gymnast's actions during release. Kerwin et al.(1993) in a more recent analysis of releases in triple back somersaults from the horizontal bar used the wrist and bar to define the effective release point. Gervais and

Tally (1993) in their study on release-regrasp skills, as opposed to dismounts, chose to define release as when effective contact with the bar was lost. They chose to identify release by combining their independent observations of the film records. Release was selected based on the apparent opening of the hand and knowledge of the skill itself. This author does contend that although this was a satisfactory method based on the agreement between the two investigators' identification of release, it was highly dependent on the quality of the film records. In the competitive environment due to poor lighting conditions for high speed cinematography, it is often necessary to compromise between film speed and exposure which can make the film quality less than ideal.

The purpose of this study was to identify the point of release from the horizontal bar through direct measurement and to correlate this occurrence to information derived by the traditional method of analysis using cinematography.

Methods

Release, for the purposes of this study, was defined as that point in time in which there was no influential interaction between the gymnast's hands and the horizontal bar. This was identified by the fingers extending during the process of letting go as verified by a contact switch between the hand and the bar.

A local area gymnast was recruited for this study. Data was collected for long hang swings, releases at the front of a swing and releases at the back of a swing. Direct measurement of release was achieved by instrumenting a hand guard with a metal strip that was connect to the A/D board. To complete the electrical circuit a 3V DC voltage was connected directly to the horizontal bar. The computer, through the A/D board, monitored the voltage thus registering a potential when the circuit was closed, (when the grip was in contact with the bar), and no potential when the circuit was open, (when the grip was not in contact with the hand). The horizontal bar that was used for this study was fitted with strain gauges thus also allowing for direct force measurement.

One of the purposes of this research was to provided a practical protocol or suggestions when using high speed cinematography (or videography). This is essential as this data collection method is the most prominent data collection method and probably the only feasible method in the competitive environment from which data on elite performances is most readily available. Two Photosonics 1PL high speed 16mm cameras electronically phased locked, operating at 100 frames per second, were used to take two views of the release skills as performed by the subject. In an attempt to provided maximum comparison to previous studies, one of the

cameras was positioned such that its optical axis was perpendicular to the primary plane of movement and had a field of view of 8 meters. This field of view was used by Harwood *et al* (1991) and by Kerwin *et al* (1990, 1993). The second camera was zoomed in on the subject's wrist and hand and on the bar during the swinging phase of the release tasks. Synchronization between film, force and switch data was achieved by collecting the camera's LED pulses on a separate channel on the A/D board as per the method of Gervais (1993).

Standard film data reduction was conducted on the processed film. Since the skills analyzed were symmetric only the right hand side of the subject, along with the bar, was digitized. Data was smoothed using a second order Butterworth digital filter. The direct measurement was used to define the point of release. From the digitized coordinates of the wrist and bar a release (RELEASE-WRIST) was found as per the definition put forth by Harwood et al. (1991) and Kerwin et al. (1993). Release (RELEASE-HAND) was also found using the approach described by Gervais and Tally (1993). These points of release for the skills recorded on the film were completed by 2 investigators independently. **A** third identification of release (RELEASE-CLOSE) was conducted using a visual interpretation of the close-up view. To acquire an estimate of the digitizing reliability selected trials were redigitized and compared.

Results and Discussion

Data was collected on 6 trials, 3 front somersault dismounts, 2 forward underswing dismounts and one release back from a longhang swing.

A mean error for the repeated digitization of the bar and wrist was 0.030 (SD=0.024) m and 0.015 (SD=0.013) m respectively. This values do suggest that identifying the precise instant of release from an image taken from 16mm film of a 8 meter field of view is far from ideal. These high error estimates may be partially explained by the small image size and less than clear view due to the bar's uprights and the gymnast's hand guards. The mean error for other body landmarks ranged from 0.007m (SD=0.003) for the knee, to 0.028m (SD=0.019) for the shoulder.

Table 1 is a comparison between the various methods of defining the instant of release. The three visual methods are compared to the direct measure of release. The values reported are by film frames (0.01 seconds), + for an estimated that defined release late (after the switch) and - for an estimated that had defined release prior to that found with the switch. Because of a highly flexible bar, continued hand adjustments by the gymnast and a small image size, determining release with the RELEASE-WRIST definition can still prove to be somewhat subjective or the data

may have to be subjected to more extensive smoothing. However, the data suggests that the RELEASE-WRIST and **RELEASE-HAND** provided similar results. It has been determined that a larger data set and use of videography will be required to provided a more conclusive recommendation as to how to define the point of release.

TABLE 1
IDENTIFICATION OF RELEASE

TRIAL	RELEASE-WRIST	RELEASE-HAND	RELEASE-CLOSE
1	+2	+1	-1
2	0	-2	-2
3	+1	-1	0
4	-3	-2	-1
5	-4	-1	-1
6	+1	+3	0

It does appear evident however that given the opportunity for an additional view that a better estimate of release can be found using a close-up view of the hands and bar.

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