

Training Uneven Parallel Bar Back Salto Dismounts

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This paper was written in an effort to describe some of the basic biomechanical issues surrounding the training and performance of uneven parallel bar back salto flyaway dismounts. The dismount is common in gymnastics and is seen first in Level 6 compulsory competition. This dismount involves fundamentals for many higher-level dismounts and release moves.

Biomechanics

To begin evaluating the performance of the salto, a basic understanding of the underlying biomechanics is necessary. This understanding includes vocabulary and concepts described in the following paragraphs.

When performing a swinging activity on the uneven bars, the axis of rotation is at the bar. This does not imply that the body is not rotating, but simply states that the point around which the body is rotating is where the hands meet the bar. The speed of the rotation is termed angular velocity and contributes to the gymnast's angular momentum. Angular momentum is analogous to the quantity of energy the gymnast has and is a function of body shape and mass. The shape and mass of the body also determine how difficult it will be to start and stop rotation. This is termed the moment of inertia (MOI) and is formally defined as a body's tendency to resist acceleration (Newton's 1st Law). An object with a large MOI requires more energy to rotate than one with a smaller MOI.

Every rotating gymnastics skill requires a certain amount of energy to be completed successfully. For the uneven parallel bar back salto dismount, this angular momentum is obtained from the swing that precedes it, energy stored in the rail and muscle tension. Body mechanics affect both the angular velocity and MOI and therefore impact the angular momentum (or energy) available at the point-of-release. After release, this energy is then used to complete the salto. Therefore, the amount of available energy affects the performance of the skill. The swing and release point are extremely important.

The final biomechanical concept related to this discussion is center-of-mass (COM). This is the theoretical balance point that every object has. Its location is a function of body shape (mass distribution) and is not always located within the volume of the body. It has a different location in the positions of tuck, pike, or layout. In a gymnast, it is linked to the concept of MOI in that a body in free-flight will rotate around its COM.

During the performance of a salto flyaway dismount, the gymnast must release the bar. The direction of flight is controlled by the direction of the COM at the point-of-release. The quantity of angular momentum is also defined at this point and does not change until the gymnast lands. During flight, the gymnast may manipulate his/her MOI resulting in changes in their angular velocity. As an example, tucking after release decreases the gymnast's MOI and results in a compensatory increase in angular velocity (because angular momentum must remain constant, i.e., be conserved). A layout position would do the opposite. The total angular momentum in the system remains constant in the absence of external torque (as might be supplied by a spotter).

Figure 1 illustrates the relationship of the point-of-release to direction-of-flight for a simple weight on a string. When the weight leaves the circular path, its initial direction will be tangent to the path at the point-of-release (A). Gravity then acts on the object to slow its ascent and reaccelerate it as it descends resulting in a parabolic flight path. For the gymnast, release at a 45° angle from horizontal (B) would maximize both height above the bar and the distance from the bar at which the height is reached during the flight phase. These can be proportionally increased with an increase in angular momentum prior to the point-of-release (swinging faster). Applying this concept to the salto dismount can create a problem. Gymnasts typically begin learning this skill from a swing. Asking the gymnast to swing faster (e.g., start the salto from a handstand or giant swing) often results in timing changes that encourages the gymnast to modify his/her body mechanics and point-of-release. If the point-of-release occurs when the gymnast's COM is going straight up, then maximum height would be achieved with little distance from the bar (C). The extreme case would be a late release that results in a flight path that would bring the gymnast closer to the bar (D). This is probably the most dangerous point-of-release since there is the potential for the gymnast to contact the bar during the salto. Finding the balance between height and distance is where coaching comes in.

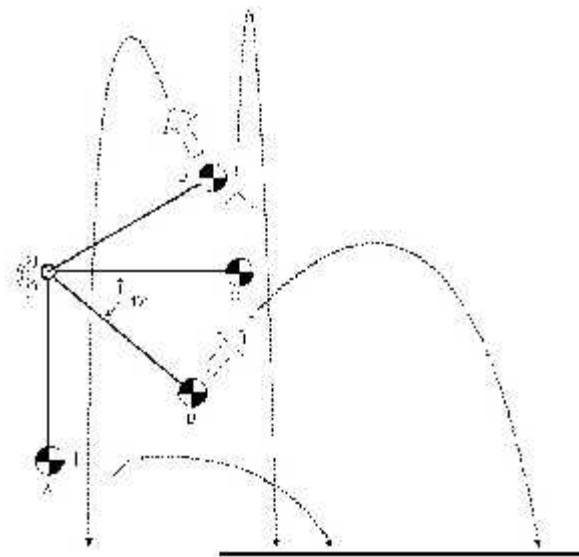


Figure 1 - The relationship between point-of-release and direction-of-flight for a weight on a string model.

The Salto

Figure 2 illustrates the components of what will be called the "optimal" salto dismount from release to landing. As mentioned before, the goal of the swing that precedes the salto is to gain sufficient angular momentum (or energy) to complete the airborne rotation phase of the skill (Figure 2-A). If two objects have the same angular velocity but different moments of inertia, the object with the larger MOI will have the most energy. A gymnast in an extended body position has a larger MOI than when he/she is tucked. Therefore, the gymnast should have more energy to deliver to the salto if he/she is able to swing as fast in the extended position as in the

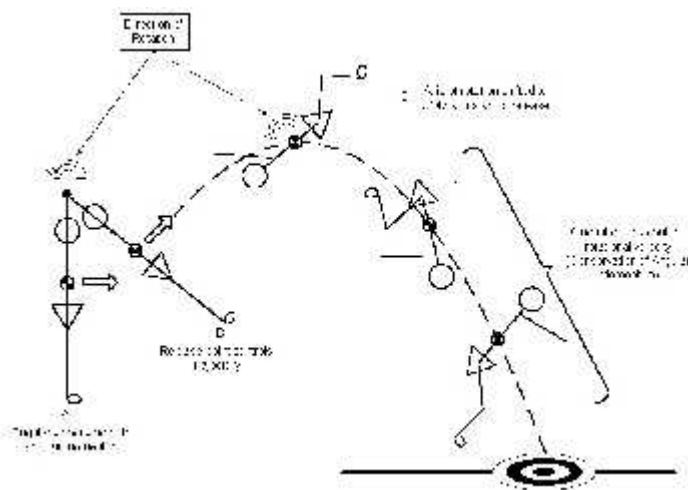


Figure 2 - Components of the back salto dismount from release to landing for an "optimal" flight path.

tucked position prior to release. Additional energy can be gained through the independent rotation of body segments. The tap-swing is an example of the total body COM having one rotational velocity around the bar and the gymnast's legs having a different rotational velocity around their hip. These energies sum to create the total angular momentum of the system. A gymnast can significantly increase the amount of energy available for the dismount by using a tap-swing technique. This technique should only be taught to higher-level gymnasts.

The extended body position also affects the direction of the COM at the point-of-release (Figure 2-B). If the gymnast is tucking as he/she releases, the direction of the COM may be more vertical than if the body was extended at the same release point. This often contributes to a salto that stays close to the bar. Height may also be compromised due to the decrease in angular momentum that results from the decreased MOI.

After release, the axis of rotation transfers from the bar to the gymnast's COM (Figure 2-C). If no additional energy is added to the system, then the angular momentum will be constant until the landing phase of the skill. This again illustrates Newton's Laws of Motion and introduces the concept of conservation of angular momentum. The gymnast can control the amount of rotational velocity by increasing or decreasing the MOI. In coaching terms, they tuck to flip faster and extend to slow down (Figure 2-D&E). The obvious goal is to control the release point and rotational energy to first commit the skill to the perfect trajectory and then to control the rotational velocity of the salto by tucking or extending to allow a successful landing. The following section will discuss what happens when the gymnast executes the skill with poor technique.

Poor technique

There are three common errors to which gymnasts succumb when first learning the salto dismount. These can all be explained from a mechanical standpoint as an effort by the gymnast to increase rotational velocity. Remember however, that increasing the rotational velocity at the expense of MOI does not always increase the total rotation energy present during the flight phase of the skill. It is important to provide training progressions that focus first on appropriate upswing technique to insure that these techniques are carried- into the release and subsequent somersault. Some training techniques will be discussed in the closing portion of this paper. The three common errors identified in this paper are not an all-inclusive list and are presented in no particular order.

1. The first common mistake occurs when the gymnast tucks too soon prior to bar release (Figure 3). Remember that the intent of the salto is to direct the COM outward and upward, and utilize as much of the stored energy from the extended swing as possible. Tucking early does two things; first it moves the COM closer to the bar at the point-of-release, changing its trajectory, and second, it decreases the amount of stored energy

available to complete the salto. Figure 3 illustrates these changes and compares the early tuck release flight path to the optimal release flight path. Note that the early tuck flight path does not go as far or as high as the optimal release flight path.

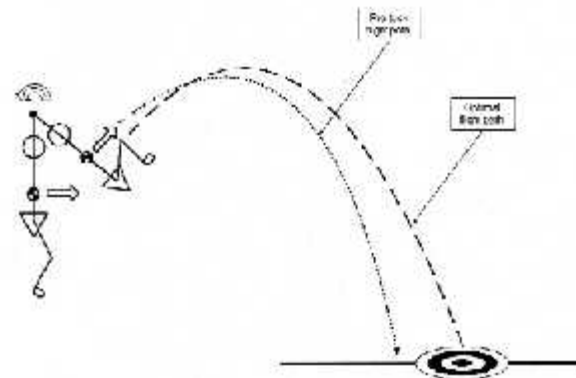


Figure 3 - Flight path for the back salto dismount performed with a pre-tuck compared to an optimal flight path.

2. The second common mistake occurs when the gymnast delays the release of the bar or closes their shoulder angle prior to release (Figure 4). This often results in the gymnast landing very close to the bar. They may, in fact, hit the bar with their feet or head as they rotate. The trajectory of the COM can actually have a path that moves closer to the bar instead of farther away from it. Anecdotal evidence suggests that the gymnast may be trying to gain additional rotational velocity by pulling down on the bar (i.e. pulling the bar towards their feet or lifting their feet towards the bar prior to release). The results can be catastrophic. Figure 4 compares the flight path for the delayed release with that of the optimal release flight path. The delayed release may make the gymnast go higher, but also keeps them very close to the bar.

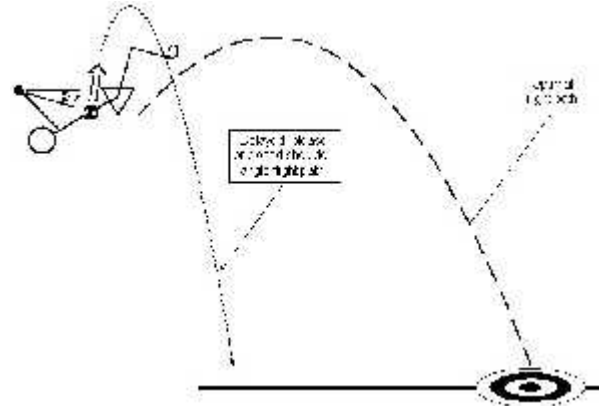


Figure 4 - Flight path of the back salto dismount performed with delayed release compared to an optimal flight path.

3. The third common mistake occurs when the gymnast throws the head back (cervical extension) before and/or after the bar is released (Figure 5). This may provide the gymnast with an earlier look at the landing surface, but severely hinders the mechanics (and aesthetics) of the skill. With the head back, the trunk typically extends, increasing the MOI of the body and making it difficult to assume a tucked, piked, or layout (candlestick) position. The release point is often too early, reducing the flight time of the skill. If the intent is a layout position, the extended head again may cause the trunk to extend making it difficult to initiate twist (future progression). Figure 5 compares the flight path of the head-back release with that of the optimal release flight path.

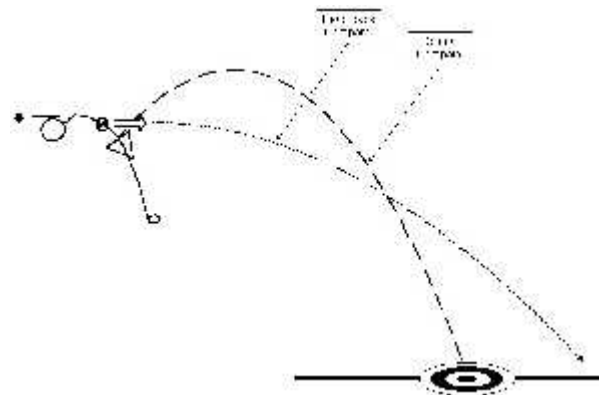


Figure 5 - Flight path of the back salto dismount performed with head back (cervical extension) compared to an optimal flight path.

Training the Skill

Below are some simple suggestions for training uneven bar back salto flyaways. They involve a

series of progressions that first introduce the gymnast to the effect that body shape has on rotation (COM location and MOI) and second, demonstrate the importance of COM direction at the point-of-release.

- Have the gymnast practice lying on the floor on their back (supine) in a candlestick position (i.e. arms overhead and legs extended and slightly above the floor). Instruct the gymnast to quickly pull their knees into a tucked position making sure that their hips leave the floor as they complete the motion. This movement shifts the COM in the gymnast up their torso and should provide the feeling of backward rotation. The same "shape" is used to execute a tucked salto from the bar. The location of the point-of-release in the swing is even similar to the supine floor position.
- Practice 2 or 3 swing backdrops onto a matted pit or floor surface. The landing position should be the same candlestick described above. It is important that the arms stay overhead and the legs stay extended to increase MOI and minimize the rotational component of the drill. The gymnast should land away from the bar (not under it). This drill can also be done or progressed by using a spotting belt. The gymnast is instructed to swing or cast into the backdrop while wearing a spotting belt. The gymnast is instructed to hold the candlestick position when they release. Using the spotting belt, the gymnast can be suspended in mid-air to experience the rotation that results from simply releasing the bar. Recall that the axis of rotation is transferred from the bar to their COM at the point-of-release. They will rotate without any additional effort.
- Practice 2 or 3 tucked swing saltos with arms over-head. This can be broken down into components where the gymnast swings to a spotter-supported position prior to releasing the bar. The gymnast is instructed to let go of the bar while being balanced on the spotter's shoulder. The gymnast is then instructed to tuck her legs while keeping arms stretched overhead. Raising the arms shifts the body toward the head and initiates the backward rotation. The spotter simply lets the gymnast roll off backwards onto his/her feet. It is important to focus on the affect that body shape has on rotation. The fact that rotation can be initiated first by simply releasing the bar and then controlled by the amount of tuck takes time for some gymnasts to understand. Progress the drill to larger swings and less manipulation from the spotter.

The complexities of training tap-swings and techniques that include shoulder and hip angle changes in the higher-level athlete follow the same basic principles, break down the skill into elements and then train the elements prior to "assembling" the final product. In backward salto flyaway dismounts, the intent is always to direct the COM away from the bar and to the highest point possible prior to landing.

Final Thoughts

When spotting a gymnast who is first learning a back salto, it may be necessary to "block" the shoulder angle to keep it open prior to the release of the bar. There is often a tendency for the gymnast to attempt a "pullover" at the end of the swing to add rotational speed to the skill (recall Figure 4). The spotter should visually follow the gymnast's COM. Focus on the trunk and hips, since where it goes, the arms and legs will follow.

Spotter's reaction time - it is easy to get caught under the bar when the gymnast begins to pull-in prior to release. Try to stay centered and be aware that the gymnast may hit the top of their feet and/or shins when they pull in. If they hit the bottom of their feet, it is possible for them to react by pushing (as they might on a spring board) and launch themselves away from the spotter. Multiple spotters may help in this instance, but anticipating the possibility is probably your best bet.

Mat appropriately. More is better (within reason). The load or pressure of impact is a function of mass, landing velocity, contact area, elasticity, and time of impact. Obviously, lighter gymnasts

produce less landing force. In addition, higher landing mats tend to reduce the gymnast's peak velocity from the descent prior to landing. Landing mats designed to cushion the impact increase the amount of time the stored force has to be released. These act together to decrease the landing force felt by the gymnast.