POSTURE CONTROL AFTER LONGITUDINAL ROTATIONS IN DIFFERENT DIRECTIONS

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Fast rotations induce load on the human organism. Hanging vertical, young figure skaters perform rotations around the longitudinal axis. After the rotations we investigated the posture control. The differences between the direction of rotations will be explored. There were no differences between the rotations to preferred and not preferred direction of the rotations, but there were individual exceptions. Angular velocity about 500 deg/sec were reached. The results of the posture control show an effect of the rotations. But there is also no effect on the direction. The postural sway after rotation to preferred direction were not different to the postural sway after rotations to the opposite direction. Further investigations will use the results of this pilot study.

KEY WORDS: posture control, longitudinal rotation, direction of rotation, figure skating

INTRODUCTION: Twisting and somersaulting are the majority skills in kind of sport like gymnastics, diving and trampoline. For example rotations around the longitudinal axis are important for figure skating (Salchow, Axle, Lutz, Toeloop, Rittberger etc.). The rotations around longitudinal axis are rapid rotational movements, because of less moment inertia. State of the art analyses demonstrated an increase of angular velocity in the most difficult longitudinal rotation movements in the last years (Knoll, Knoll & Koethe, 2000). Highest twisting velocity (2100 deg per sec) were analyzed with a quadruple Salchow in men figure skating. One important difference between longitudinal and somersault rotations for competition skills is the direction of the rotation. Athletes in gymnastics or diving need to perform somersaults forward and backward. For twisting and longitudinal rotation there is the possibility to choose the direction, left or right. Some studies explore the selection of twist direction of athletes. Sands (2000) investigate the relative distribution of twist directions of 244 gymnasts. The results showed no statistically difference in selection between the preferred twisting directions left or right of different skills.

But there is another field of interest. Fast rotational movements induce load on the human organism. Several studies had presented results of posture control after different sporting loads. (for example Lepers et al., 1997) Naundorf & Krug (2000) have reported some findings about posture control after somersault rotations. It could have been shown that the postural sway was much more higher after somersault rotations in a "somersault simulator" than before. The purpose of the present pilot study is to scrutinize, if fast longitudinal rotations have the same effect. It can be supported that sway limited performance after the rotations. Probably sports technical elements after longitudinal rotations will be negative affected.

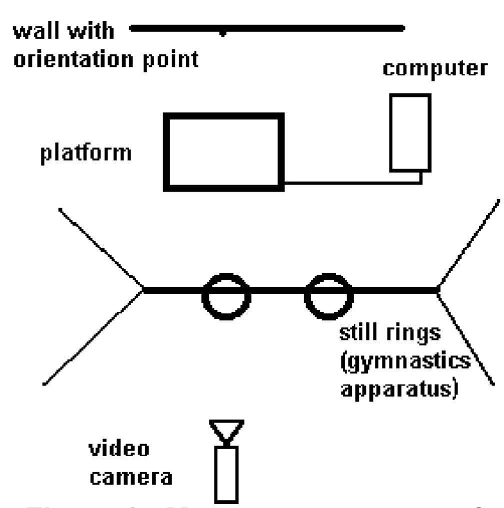

Figure 1 - Measurement system for the pilot study.

METHOD: An investigation was carried out to study the postural stability after twist rotations. A measuring system was configured with a force plate (Kistler), rings (gymnastics apparatus), video camera and a computer for recording the data (see figure 1). The force components F_x, F_y, F_z and the moment components M_x, M_y were registered. The center of pressure (COP) was calculated by the recording software with the before named parameters. Five youth figure skaters from German junior national team took part in the pilot study. All Subjects (Ss) has to perform ten longitudinal rotations in both directions.

To avoid learning effects, two Ss start to left direction and three to right direction. Ss, hanging on one ring of the gymnastics apparatus, had to rotate with the "Hula Hoop"-technique (see figure 2). A circular rotation of the hip will cause an opposite moment of force which rotates the trunk around the longitudinal axis, so that a twisting movement appears (Hong & Brueggemann, 1993; Fink, 1997). Before the rotations without any load the pre-test on a dynamometric platform was realized (time span 30 sec; sampling rate 300 Hz). Ss has to go to the platform and remain standing with open eyes and look to an orientation point on a wall. During the 30 sec athletes has to count seven in seven steps backwards from 700. These task was given to avoid arbitrarily posture corrections. After the pre-test the figure skater hanging at the ring and perform ten rotations in one defined direction. After the tenth rotation an assistant stop the athletes. Ss had to go as quickly as possible to the platform for the post-test. Standing position was same as in the pre-test and again the instruction was to count in three steps backwards from 300. After 20 minutes Ss has to do another pre-test and perform the ten longitudinal rotations to opposite direction. After the rotations athletes must do the post-test on platform. There was always the instruction to count numbers and look to the wall with orientation point.

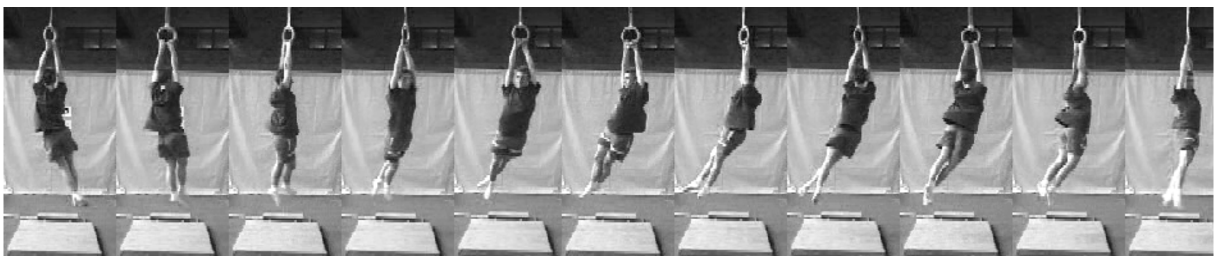

Figure 2 - Subject on a ring twisting with "Hula Hoop"-technique.

To analyze the data we use a software, which was programmed by our own on the basis of object oriented programming using the compiler HP VEE 5.0. This analyzing software divided the data in three periods. The "period of landing" is the time when the subject take the step on the platform, the "period of regulation" for the time when athletes sway more then in the pre-test and a "period of stability" if the athletes sway like in the pre-test. This system was presented by Naundorf and Krug (2000). We focused our attention only to the period of regulation, because that is the time when rotational load effect is measurable. Dependent measures were the time of the period of regulation and the sway in this time. The sway was operationalize by the way of the center of pressure. This parameter was the mean of a_{res}, calculated in following equation:

$$a_{res} = \sqrt{(a_{x(i)} - a_{x(i+1)})^2 + (a_{y(i)} - a_{y(i+1)})^2}$$

where: a_x and a_y coordinates of the center of pressure

For statistical analysis the software package SPSS 9.0 was used. For description of the angular velocity an explorative data analysis was set in. Paired samples, independent samples t-test and the Analysis of variance (ANOVA) with repeated-measures (pre- and post-test) plus a between-subjects effect (direction of rotation) were utilized for interference statistical analysis.

RESULTS AND DISCUSSION: The preferred direction of rotation of all Ss was rotate to the left side. At first we analyzed the angular velocity of the athletes. On the basis of the video from the rotations with time code based, we determined the time per rotation and calculated the angular velocity of every rotation. One participant was not able to do all the rotations of his own. In this situation an assistant help the athlete to get all the rotations. The angular velocity of the athletes, who perform the twist without help, is showed in figure 3. Using the explorative data analysis with error bars in figure 3 it is obvious that there is no statistical difference between the direction of rotation. The error bars overlie each other. Using the independent samples t-test this result is confirmed ($T_{(1,72)} = 1.454$; $p > .05$). The mean values are 544 deg/sec (left) and 498 deg/sec (right). These angular velocity is only comparable with basic skills in figure skating. An

single case analysis have showed there is one athlete (subject J, figure 4), who has hade clear differences between left and right direction of rotation.
To avoid learning effects we compare the athletes starting with left direction of rotation with the group starting to right direction. There were no statistical difference between the parameters of the two groups.
In addition to the analysis above, we compare the parameter time of the "period of regulation". There was an significant increase from pre- to post-test ($F_{(1,8)} = 5.729$; $p < .05$) (see figure 5). But there was no between-subject effect for the twist direction ($F_{(1,8)} = .223$; $p > .05$). Regarding the parameter sway (a_{res}) there was no statistical difference between the pre- and post-test ($F_{(1,8)} = 1{,}447$; $p > .05$) and no effect of the twist direction ($F_{(1,8)} = 1{,}636$; $p > .05$).

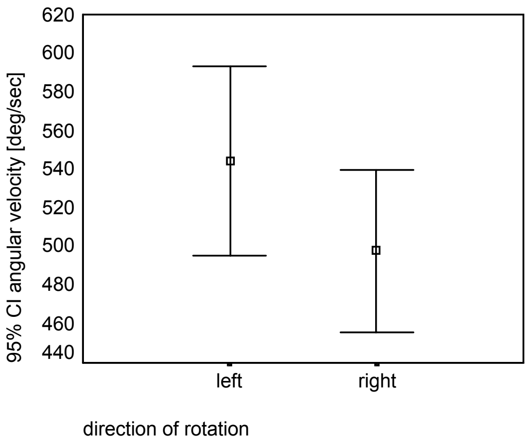

Figure 4 - Error bar for all Ss, angular velocity of the rotations (without assistant help).

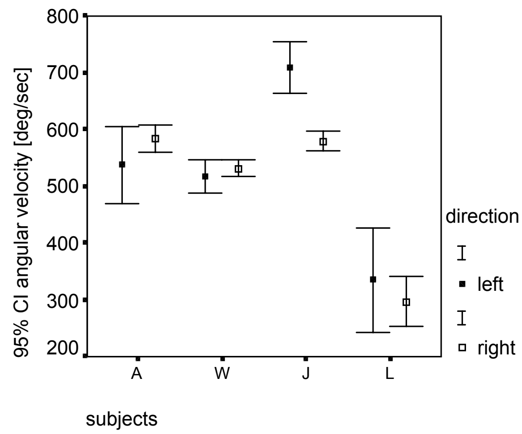

Figure 3 - Error bars for individual analyze of angular velocity in different directions.

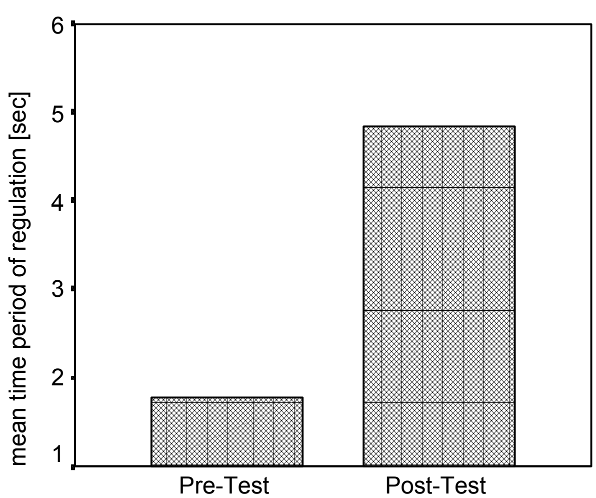

Figure 5 - Comparison of the time for the period of regulation.

CONCLUSION: All together we can report, there is an influence of the longitudinal rotations to posture control, but there was no

differences between the direction of the rotations. There could be some reasons for this result. The angular velocity of the longitudinal rotations was only comparable with basic skills in figure skating, gymnastics, diving and trampoline. But there is an difference to the angular velocity of difficulty skills (difficult jumps with up to four rotations) for juniors and adult in figure skating.
The results of these pilot study are reasons for further investigations. The measurement system will be expanded. The longitudinal rotations will not perform on the gymnastics apparatus rings. There is a new device for the longitudinal rotations. Participants hang on a ring, which is fixed on an axle. The rotational velocity will be measured by a speedometer. So it is possible to record simultaneously the angular velocity. Further experiments there will be gymnasts, who will perform the longitudinal rotations. It will be expect that gymnasts will attain higher angular velocity, because they used the “Hula Hoop”-technique for skills in their kind of sport.

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