

# TEAM PULLING TECHNIQUE OF THE TUG OF WAR -A BIRDS-EYE ANALYSIS OF TOW

**Mukwaya Godfrey, Masahiro Nakagawa and Hiroh Yamamoto**  
**Biomechanics Lab., Fac. of Educ., Kanazawa Univ., Japan**

The purpose of this study was to clarify the loss of the force on first 1 second of drop phase for Japanese female elite tug of war team from view point of a backward pulling direction. In order to examine the pulling movement, performances of 10 teams in 2006 All Japan Tug of War Championship tournament were videotaped from directly above the lane by digital video camera located near the ceiling of gymnasium. The team slanting angle was measured by using two-dimensional motion analysis system. About 0.5 % of team pulling force was wasted in first drop phase for female elite tug of war team. This is small compared with total loss of the team pulling force (about 20%. Liou et al. 2005). The lateral slanting has likely no relation with the loss of the force in drop phase.

**KEY WORDS:** tug of war, the loss of team pulling force, pulling direction, straightway

## INTRODUCTION:

Tug of war is one of the team sports where it is important to utilize the maximum force of all players. The team pulling force is about 20% smaller than sum of force exerted by 8 players; with the loss of force due to a lack of coordination between players (Liou et al. 2005). Pulling movement in tug of war can be divided into three phases: “drop”, “hold” and “drive” phase. It is considered that drop phase is the stage that pullers put pulling force rapidly right after the start of pulling, hold phase is the stage that pullers hold against pulling of opponent, and drive phase is that the part of stage when pullers exert pulling force with backward walking, drawing the opponent into their own side (Nakagawa et al. 2005). The drop phase may be the most important because this phase is the stage when maximum pulling force is exerted (Tu et al. 2005). Tanaka et al. (2006) suggests importance of timing skill of drop phase is to avoid the loss of pulling force in tug of war. Also, Liou et al. (2005) investigated relationships of pulling direction and the loss of team pulling force at the sagittal plane. However, few studies focused on each phase of the tug of war in a match and on horizontal plane. Thus, the purpose of this study was to clarify the loss of force on 1 second of drop phase for Japanese female elite tug of war team from view point of backward pulling direction in horizontal plane.

## METHODS:

Ten matches performed by 10 teams were recorded by digital video camera (30fps) were set right above the one side of the competition lane (Figure2). These matches were trial game in All Japan Tug of War Championship women’s lightweight division (A total of weight of 8 people must be less than 480 kg). All teams, videotaped in this study, won these games, and all participants held rope under their right arm. To investigate shape of the rope, angles which made by two lines: one is the line cross center line of official lane at right angles and another is the line made by the two pullers in line were measured by using the two-dimensional motion analysis system (Frame-DIAS for Windows, DKH, Japan).

Unit of measure was 1 second right after “pull” signal which signals the start of competition. Control points were defined as intersection point of rope and under the right shoulder. The slanting angles, defined as Figure 2, were measured. Sum of 7 angles was calculated and named team slanting angle. In addition, the percentage of loss of team pulling force ( $F_l$ ) was calculated from team slanting angle as below (1).

$$F_l = \sum_{k=1}^7 100 \times (1 - \cos \theta_k)$$

(1)  $F_l$  means percentage of the loss of team pulling force



Figure 1 An image recorded in match

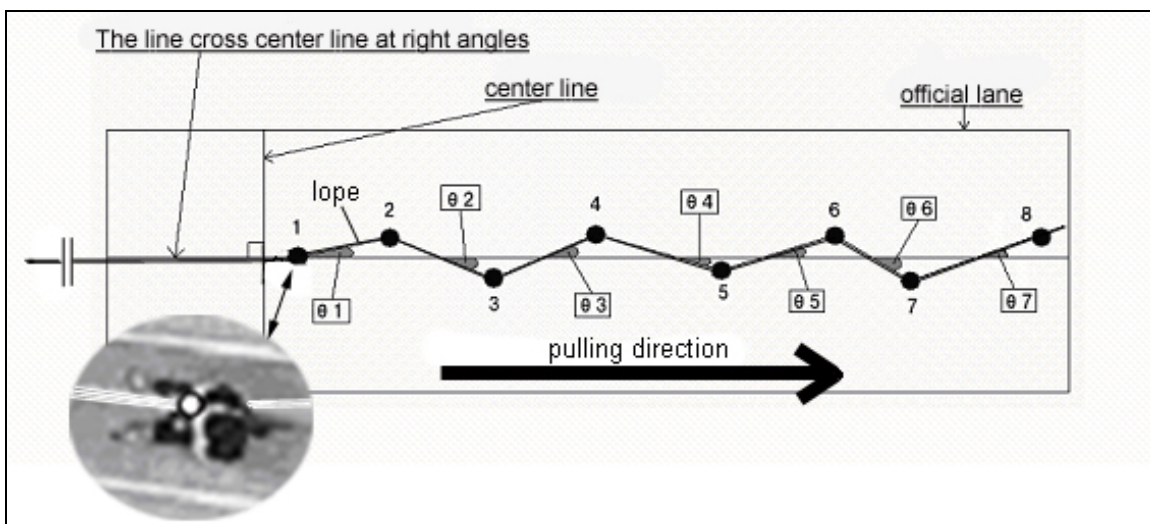


Figure 2 The angles made from the two lines: the line cross center line at right angles and the line connect two pullers, were defined as  $\theta_1$ - $\theta_7$  from the front.

## RESULTS:

Table 1 shows all data measured in this study. A mean of about 0.5 % of team pulling force was wasted in first drop phase for female elite tug of war team.

## DISCUSSIONS:

Team slanting angle in this study was confined to matters of lateral movement. There is another team slanting angle in tug of war game, vertical slanting angle. As for vertical slanting angle, some teams make the rope a curving line on purpose to maintain the better pulling posture. The other way, for team lateral slanting angle, to keep the rope straight reduces the loss of team pulling force. In this study, about 0.5 % of team pulling force was wasted in first drop phase for female elite tug of war team. It is small compared with total loss of the team pulling force (about 20%. Liou et al. 2005). Timing skill (Tanaka et al. 2006) and other factors may have an effect on the loss of the force in drop phase,

however, for the most part, lateral slanting angle has very little relation to the loss of the total force. However, other phases, hold and drive phase, were not examined in this study. It is hard to keep straight line in these phases, however they should be examined further.

**Table 1  $F_I$  (the loss of team pulling force by lateral slanting angle)**

team	The loss of team pulling force (%)
1	0.22
2	0.84
3	0.26
4	0.96
5	0.47
6	0.36
7	0.44
8	0.68
9	0.47
10	0.30
mean	0.50
SD	0.25

#### **CONCLUSIONS:**

The purpose of this study was to clarify the loss of the team pulling force on 1 second of drop phase for Japanese female elite tug of war team from view point of backward pulling direction in horizontal plane. About 0.5 % of team pulling force was wasted in first drop phase for female elite tug of war team. The lateral slanting has very little relation with the loss of the force in drop phase.

#### **REFERENCES:**

- ChunHui Liou, Tzu-Lin Wong, Jin-Cherng Wang & Jung-Chan Shin (2005). The study of team resultant force vanishing percentage in elite tug of war players. *Proceedings of XXIII ISBS*, Beijing, 1, 399-401.
- Jui-Hung Tu, Chien-Hsun Lee, Yung-Hsing Chiu (2005). The analysis of pulling force curves in Tug-of-war. *Proceedings of XXIII ISBS*, Beijing, 2, 487-490.
- Nakagawa Masahiro, Fuki Toryu, Katsue Tanaka, Shigeki Kawahara and Hiroh Yamamoto (2005). Characteristics of pulling movement for Japanese elite tug of war athletes. *Proceedings of XXIII ISBS*, Beijing, 2, 475-478.
- Tanaka Katsue, Shigeki Kawahara, Naotoshi Minamitani, Motoi Fukushima, Cao Yulin and Hiroh Yamamoto (2006). Analysis of timing skill of drop exercise in elite indoor tug of war athletes. *Proceedings of XXIV ISBS*, Salzburg, 1, 363-366.

#### *Acknowledgement*

We are grateful thanks that Natsue Nakagawa and her child supported us to describe this paper.