EVALUATION OF BREAST SUPPORTS WITH DIFFERENT BRAS DURING JUMP-LANDING MANEUVERS

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This study attempted to evaluate kinematic of the breast with different breast support during jump-landing maneuvers. Twelve C cup female volleyball athletes were recruited in this study. Markers were attached to the subject's nipples and trunk to calculate relative 3D breast kinematics data. The subject had to wear four kinds of bras (no bra, normal bra, fashion bra, and sport bra) to evaluation of breast support in the medio-lateral, anterio-posterior, and vertical directions. Results of current study showed that the sports bra was effective in reducing the amplitude of breast displacement, velocity, acceleration, and comfort scale during jump-landing than no bra situation, everyday bra, and fashion bra. Future studies should be focus on analyzing different types of sports bras in order to identify 3D breast kinematics with different bras during jump-landing maneuvers.

KEY WORDS: kinematics, sports bras, women, exercise

INTRODUCTION: Breasts are one of the secondary sexual characteristics of females. They are suspended at front of the chest, overlay the pectoralis major muscles, and extend into the axilla at the sides of chest. Breasts are composed of adipose tissue and glandular tissue. The subcutaneous adipose tissues give the breast its size and shape. Skin and Cooper ligaments provide the support for the breasts, though those structures can't effectively limit breast displacement. (Mason, Page, & Fallon, 1999; Page & Steele, 1999; Scurr, White, & Hedger, 2009). Excessive displacement or prolonged movement during physical activities place large forces on those supportive structures and may cause Cooper ligaments laxity or rupture. Daily bras was invented in 1961 which is not only cover the body, but also provide special demands. However, Yuan-Shen Wang(2003) found there are lots of problems wearing daily bra or fashion bra during exercise. For example, hook of bra loose during exercise, straps slip off shoulders, skin rubbing/chafing, insufficient support, breast pain and uncomfortable. Otherwise, there are also inadequate perspiration and over-digging problems (Mason et al., 1999). Most problems are correlated to breast displacement. The improvement of special demands is far away from appearance. This study was to investigate the correlation between different bras and breast support during jump-landing maneuver, suspected to help manufacture to design both aesthetic and functional sports bras.

METHODS: We recruited twelve C cup breast size (the difference between bust and underbust girth>15±2.5cm) female volleyball athletes in the study. All of them were pre-menopausal and not currently breast feeding or pregnant in one year to diminish the influence of hormone level. Also, non of them were had breast surgery or breast injury. All subjects were written informed consents to participate in the study.
Subjects were ask to do counter movement jump in four randomly ordered bra conditions: no bra, normal bra (without underwire, 75% Polyamide, 15% Cotton, 10% Spandex), fashion bra (with underwire, 40% Rayon, 30% Polyester, 15% Cotton, 10% Polyamide fiber, 5% Elastic fiber), sports bra (81% Nylon, 19% Elastic fiber). To quantify breast motion relative to trunk motion, passive retro-reflective markers (1.27cm diameter) were placed directly on both nipples under each bra. Reference markers were also placed on each subject's sternal notch and both side anterior inferior aspect of the 10th rib to represent torso movement. There's no relative movement between bra and skin (Mason et al., 1999; Scurr et al., 2009; Scurr, white, & Hedger, 2010, 2011; Starr et al., 2005). All breast kinematic data including three dimension displacement, velocity, and acceleration were collected at least five times successful jump-landing in every kind condition. All breast kinematic data were collected and analyzed by Vicon Nexus software. Beside those data, subjects were ask to rate their breast pain immediately after each jump trial.

All statistical data were computed using SPSS software. The breast kinematic data and subjective pain scale of different bra were analyzed by one-way repeated-measures ANOVA. LSD *post hoc* test was used if there was significant difference among four supported conditions. Significant level was set at .05.

RESULTS: Table 1 showed that the average breast displacement of left and right nipple in different kind of bras. There was no significant differences between two breasts. Therefore, the left nipple would be used for the measures.

Breast displacement. Figure 1 showed breast displacement of left breast in jump-landing maneuver. The vertical displacement were 5mm in downward direction and 38mm in upward direction without wearing bra, and significantly decreased to 22mm in upward direction with wearing sports bra. Wearing daily bra with and without underwire can decrease vertical displacement, though there was no significant difference compared to without bra. No matter wearing what kinds of bras, the mediolateral displacement decreased significantly. The sports bra was the most effective one. Though wearing sports bra can decrease anteroposterior displacement, there was no significant difference between four conditions.

Breast velocity. Figure 2 showed breast velocity of left breast in jump-landing maneuver. Wearing bra can significantly decrease vertical breast velocity. However, there was no difference between wearing daily bra without underwire and with underwire. Wearing sports bra can significantly decrease vertical breast acceleration compared to other bras. No difference in anterioposterior and mediolateral breast acceleration was noted between four conditions.

Breast acceleration. Wearing bra can significantly decrease vertical breast acceleration. There was no difference between wearing daily bra without underwire and with underwire. However, wearing sports bra can significantly decrease vertical breast acceleration compared to other bras. No any difference in anterioposterior and mediolateral breast acceleration was noted between four conditions.

Breast discomfort. Breast discomfort was correlated with breast support in jump-landing maneuver. In our study, the average pain scale was 6 in jump-landing maneuver without wearing bra, 5 in subjects wearing daily bra without underwire, 4 in subjects wearing daily bra with underwire, and dropped to 2 in wearing sports bra.

Table 1 Breast displacement in different bra condition

	No bra		Normal bra		Fashion bra		Sports bra	
	Left	Right	Left	Right	Left	Right	Left	Right
Anterio-posterior (mm)	31.7	32.2	25.9	27.3	24.9	27.2	24.5	25.4
Medio-lateral (mm)	33.7	32.1	17.1	17.8	17.7	18.7	12.3	13.1
Vertical (mm)	51.5	50.7	42.7	43.7	41.2	40.1	28.8	29.3

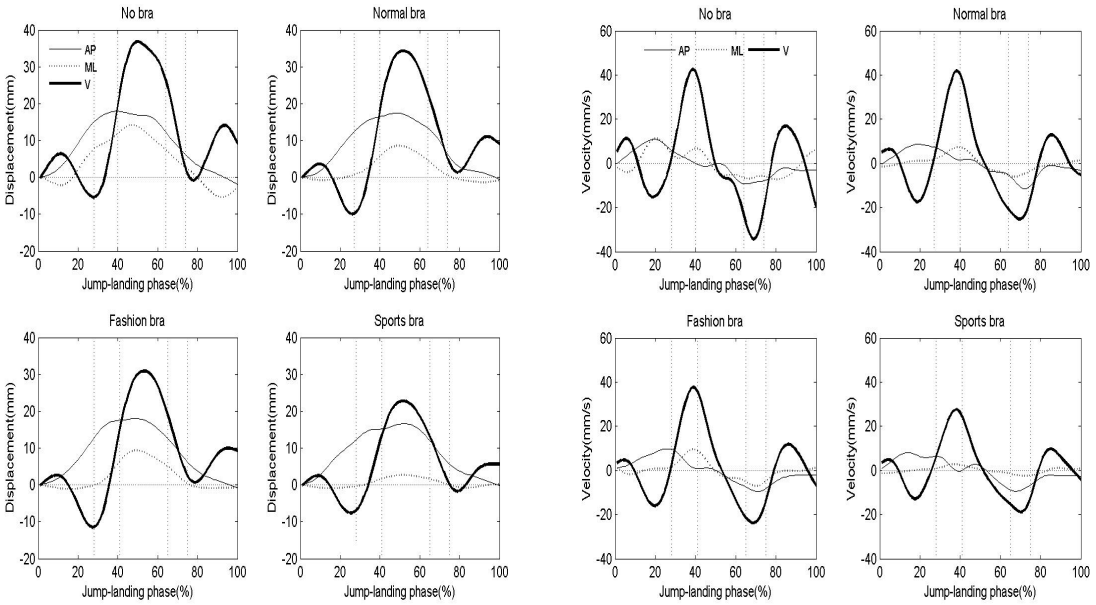

Figure 1 Breast displacement in different bra condition
Figure 2 Breast velocity in different bra condition

DISCUSSION: The purpose of the study was to investigate the correlation between different bras and breast support. We used biomechanics analysis to quantify breast stability during exercise and found that sports bra can significant decrease breast displacement, velocity, acceleration, and also pain scale during jumping. The results were similar to previous studies. The mediolateral breast displacement was significant reduced in every kind of bras, especially sports bra, approximately 63.5% decrease. White et al. has found that mediolateral breast motion were mainly caused by mediolateral body motion. Sports bras use less-elastic fabric(81% Nylon) for the centre gore and cradle to limit sagittal plane motion. Beside that, vertical displacement was biggest in jump-landing maneuver which is caused by vertical body motion and vertical impact force. Although wearing sports bra can significant reduce vertical motion from 51.5mm to 28.8mm, around 44% decrease. That still can cause irreversible injury. Manufactures should be focus on specific properties of different motion in every motion plane to design sports bras.
Breast pain was one of the main reason which cause women stay away from exercise. In our study, we found women with large breast felt less breast discomfort when wearing no bra(VAS 6/10) compared to previous studies. That may due to less breast displacement in this study. Though we still found great breast pain decrease when jumping with wearing sports bra.

CONCLUSION: Sports bras can effectively decrease not only objective vertical breast displacement, velocity, and acceleration, but also subjective breast discomfort during jumping. This suggested that every woman should wear sports bra instead of daily bra during exercise.

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