Differences in pull-up posture between adult ballet practitioners and ballet dancers: Analysis of cross sectional area of trunk muscles and spinal column alignment

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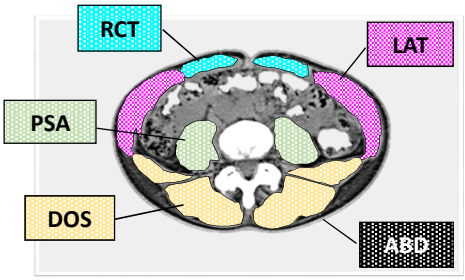
Purpose: In Japan, the number of adults who undertake ballet without childhood training, adult ballet practitioners (ABPs), is increasing. In classical ballet, dancers must maintain a rigid, erect body posture (pull-up posture), which reduces the physiological curvature of the spine. A proper ballet posture is very important for producing smooth motion. On X-ray and computed tomography (CT) scans, we compared the pull-up posture of ABPs and dancers who have been trained in ballet from childhood.

Subjects: Two female professional ballet dancers (PBDs; A,B),
Two female ordinary ballet practitioners (OBPs; C,D),
Five female adult Ballet practitioners ABPs (E–I)

Demographic Data of Participants

	PBD.OBP (N = 4)	ABP (N = 5)
Age (year)	30.2 ± 1.26	57 ± 4.81
Height (cm)	158.5 ± 0.95	158.2 ± 3.25
Weight (kg)	44.9 ± 3.07	47.2 ± 2.31
Body Mass Index (BMI)	17.88 ± 1.16	18.89 ± 1.36
Ballet experience (year)	24.3 ± 4.35	12.0 ± 6.78

Method1 Evaluation of trunk muscles



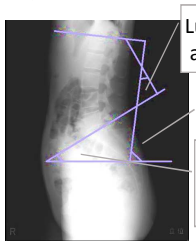
RCT: rectus abdominis
LAT: lateral abdominals
PSA: psoas major
DOS: dorsal muscles
ABD: all abdomen

CT scanning was performed once at the navel level. From CT scans, the cross-sectional area were measured using computer software .

Method2 Evaluation of spinal curvature

① Normal standing posture (NP) ② Ballet posture (BP)

X-ray image was taken with standing in normal posture (NP) and required ballet posture (BP) with ballet foot 5th position.



Spinal alignment was evaluated by measuring the sacral inclination angle (SIA), lumbar lordosis angle (LLA), and pull-up angle (PUA)

Analysis: Changes in SIA, LLA, and PUA were measured as the participants moved from NP to BP. The correlation with the spine angle change and the trunk muscle cross-sectional areas were measured.

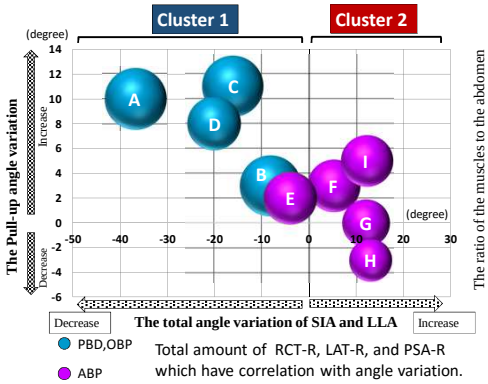
Results: Movement from NP to BP resulted in changes to all measured angles. For the cluster analysis of angle change variations and RCT-R, LAT-R, and PSA-R, the participants were divided into two clusters, and SIA and LLA differed between the clusters.

Correlation coefficients for angle variations and trunk muscle area ratios.

	SIA	LLA	PUA
ABD-A	0.428	0.453	-0.598
RCT-A	-0.413	-0.164	-0.026
LAT-A	-0.493	-0.578	0.412
PSA-A	-0.801 **	-0.886 **	0.851 **
DOL-A	0.276	0.268	-0.654
RCT-R	-0.717 *	-0.749 *	0.711 *
LAT-R	-0.613	-0.677 *	0.724 *
PSA-R	-0.723 *	-0.809 **	0.800 **
DOL-R	-0.564	-0.540	0.295

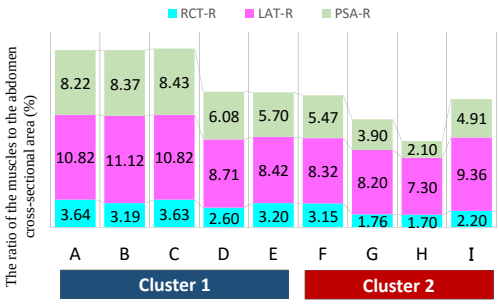
PSA-A (A: actual measurement), RCT-R, LAT-R, and PSA-R (R: the ratio of muscle areas to abdominal cross-sectional area) correlated with angle variations.

PUA relevance with the total angle variation of SIA and LLA



Total amount of RCT-R, LAT-R, and PSA-R which have correlation with angle variation.

RCT-R,LAT-R, and PAS-R Difference between the Participants



There was difference between the cluster.
RCT-R* : PSA-R** (*p<0.05, **p<0.01)

Discussion:

Cluster 1 (PBDs, OBPs, one of ABP)
- Decrease SIAs and LLAs (Reduce physiological curvature)
- Increase PUAs (Erect spine)

Correct pull-up posture

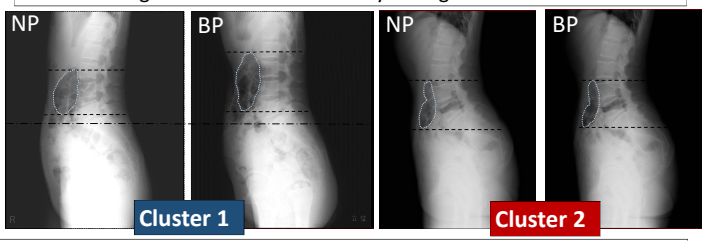
Cluster 2 (ABPs)
- Increase SIAs and LLAs (Increase physiological curvature)
- PUAs: differ between the subjects

Incorrect pull-up posture

SIAs ,LLAs → Correlation → **RCT, PSA, LAT**

RCT, PSA, and LAT, play major roles in changing spinal column alignment.

Internal changes in the abdominal cavity during transition from NP to BP.



LAT is one of the important muscle in sustaining intra-abdominal pressure (IAP) to support the spinal column. RCT and IAP are very important for trunk stabilization.

Conclusion:

Less abdominal muscles make it difficult for ABPs to achieve the correct pull-up posture.

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