Three-dimensional Kinematic Analysis and Muscle Activation of the Upper Extremity in Ruesi Dutton Exercises

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ABSTRACT

Objective: To investigate 3-D upper extremity joint angles and muscle activities in selected Ruesi-Dutton exercises.

Material and Methods: Twenty-six healthy participants (mean age of 25.65, mean height of 165.08 cm, and mean weight of 56.69 Kg) volunteered to take part in this study. 3-D motion analysis consisted of eight cameras synchronized with a wireless electromyography (EMG) system to collect kinematic data and muscle activity. Participants performed five postures, including the Kae Lom Kho Mue posture, Kae Puat Thong Kae Kho Thao posture, Kae Kiat posture, Kae Puat Thong Sabak Chom posture, and Kae Lom Puat Sisa. The upper extremity joint angles and range of motion (ROM) and EMG were analyzed.

Results: Most postures were in the normal range of motion. The percentage of MVIC was more than 1% and the Trapezius muscle is the most active in all postures.

Conclusion: The data in this research is useful to help select the correct posture and exercise for a specific condition.

Keywords: Ruesi-Dutton; Hermit Doing Body Contortion; biomechanics; upper extremity (Siriraj Med J 2022; 74: 721-730)

INTRODUCTION

Ruesi-Dutton or Hermit Doing Body Contortion (HDBC) is an exercise that has been used for over 200 years in health care.[1] Its origin is still unclear, but it was believed to have been developed by hermits who practiced it in India.[2] "Ruesi-Dutton" is composed of two words; Ruesi, which means hermit or monk from the Buddhist era and refers to people who renounced their home, practiced Buddhist teachings, and sought peace, and "Dutton", which means an exercise.[3] Therefore, Ruesi Dutton means movement or the many postures the Ruesi used to practice Buddhist teachings and relieve pain. HDBC exercises (also known as postures) are commonly performed by moving a part of the body in a sequence or performed simultaneously for a determined posture and held for five to 10 seconds, similar to an active static exercise. Then, the body is slowly returned to the start position. Each posture is repeated three to five times.[4] HDBC consists of 80 postures, including the standing posture, sitting posture, and supine posture.[1]

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There are many benefits of HDBC exercises such as pain reduction, decreased blood pressure, increased angle of joints, increased muscle strength, and improved quality of life.[5-7]

Although HDBC is widely practiced, it is still unclear how to do this exercise correctly. This problem is the result of insufficient evidence on how to perform this exercise. For example, statues in Wat Phra Chetuphon Wimonmangkalaram or paintings only display the end posture of a contortion. Moreover, a poem in Thai scripture only describes the hermit's history, the benefits of postures, and the preliminary steps leading to variations in HDBC. In addition, research studies relating to HDBC are associated with the effectiveness of the postures. Currently, no study has comprehensively investigated movement patterns and muscle activity in HDBS. Understanding these movement patterns and how the muscles perform provides essential information to study the characteristics of the exercise. Therefore, this study aims to investigate the 3-dimensional kinematics and muscle activities of HDBC postures related to the upper extremities.

MATERIALS AND METHODS

Study design

This cross-sectional study was conducted at the Faculty of Medicine Siriraj Hospital, Bangkok, Thailand. The protocol of this study was approved by the Siriraj Institutional Review Board [Si 365/2016 (EC3)] and registered in the Thai Clinical Trials Registry (TCTR20211014004). The experimental protocol, risks, and benefits of the study were clearly explained to participants. All participants then signed and gave their informed consent before data collection.

Subjects and Sample Size calculation

Healthy volunteers aged between 18-32 were recruited for this study. The inclusion criteria was a waist circumference of less than or equal to 90 cm (36 inches) in males and 80 cm (32 inches) in females. Participants were excluded if they were pregnant, had neurological diseases, had musculoskeletal diseases, or had a history of allergic reactions to alcohol and adhesive tape.

The sample size was calculated for primary objectives. A study on degrees of movement of the neck[8] was determined as follows; two-tailed test, confidence interval of 95%, standard deviation of s 11.1, and an acceptable error of 5.4. Twenty-six participants were required for this study. We enrolled participants compatible with our eligibility criteria using a convenience sampling method. A total of 26 subjects consisting of 13 males and 13 females, with a mean age of 25.65 ± 2.77, mean weight of 56.69 ± 10.54 kg, a mean height of 165.08 ± 8.50 cm, mean BMI of 20.65 ± 2.49 kg/m^2 (which is considered normal), mean length of right arm being 55.12 ± 4.68 cm., and a mean length of the left arm 55.12 ± 4.68 cm were enrolled.

Ruesi Dutton exercises

The selected five postures were as follows; Kae Lom Kho Mue posture (P1), Kae Puat Thong Kae Kho Thao posture (P2), Kae Kiat posture (P3), Kae Puat Thong Sabak Chom posture (P4), and Kae Lom Puat Sisa posture (P5). The procedures for the postures were chosen from *Kaiborihan Baep Ruesi Dutton Volume 1*.[4]

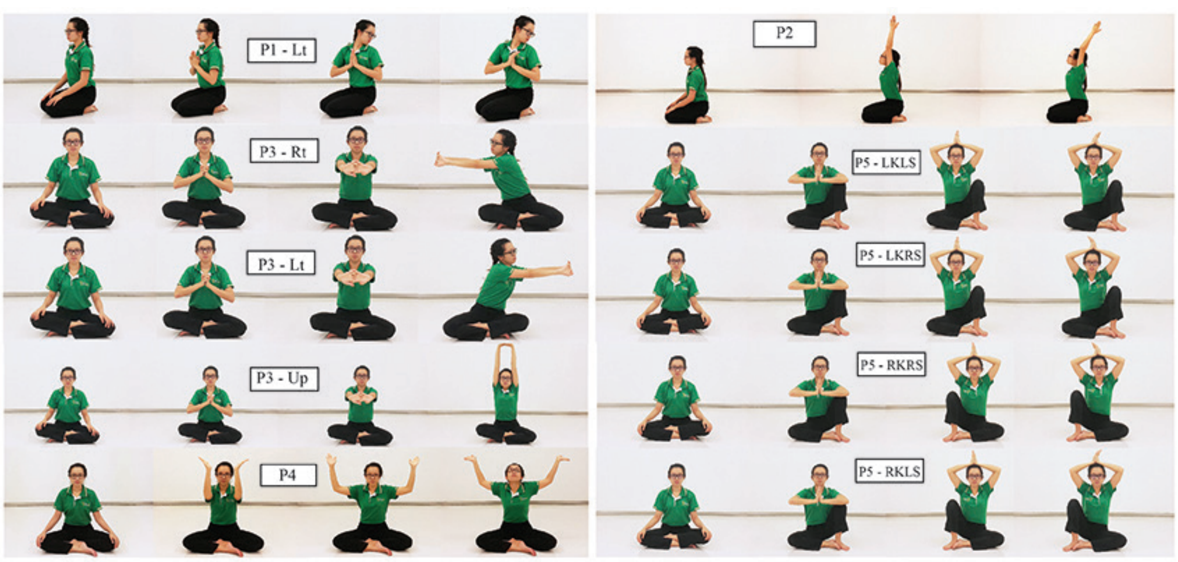

Fig 1. Five postures of Ruesi-Dutton; Kae Lom Kho Mue Posture (P1) consists of left (P1-Lt) directions, Kae Puat Thong Kae Kho Thao Posture (P2) has 1 direction, Kae Kiat Posture (P3) consists of 3 directions as follows, left (P3-Lt), right (P3-Rt), and upward (P3-Up). Kae Puat Thong Sabak Chom Posture (P4) has 1 direction, and Kae Lom Puat Sisa Posture (P5) consists of 4 directions as follows, left knees left side(P5-LKLS), left knee right side (LKRS), right knee right side (RKRS), and right knee left side (RKLS).

Study Flow

Participants who passed the criteria were trained to perform the five postures using video media and were closely advised by Applied Thai Traditional practitioners while training for a total of 120 minutes. After that, participants were assessed on each posture by three expert Applied Thai Traditional practitioners with at least 10-years of experience. Following this, various areas of the participants' skin was prepared by cleaning it with alcohol and shaving skin hair to reduce interference noise when attaching an EMG to the surface. The surface Electromyography (Trigno Wireless system, Delsys Inc, Boston, MA USA) was set at a sampling rate of 1,000 Hz and placed on the Deltoid Medius muscle, the Upper Trapezius muscle, the Middle Trapezius muscle, the Lower Trapezius muscle, the Biceps muscle, and the Triceps muscle as indicated per the SENIAM protocol.[9] Maximum Voluntary Isometric Contraction (MVIC) data was collected by stimulating static muscle strength.[10] Participants were warmed up by being told to do stretching exercises for five minutes, and then begin the determined position and to slowly start increasing their force to maximum and hold it for five seconds and promptly relax. They were then asked to repeat these three times, with a pause period of 30 seconds in between tests.

Then, reflective markers were attached on the skin of participants according to the Plug-in gait protocol.[11] The markers were attached at the following positions: left and right front head, left and right back head, 7th cervical vertebrae, 10th thoracic vertebrae, clavicle, sternum, and right back, right and left shoulder, right and left upper arm, right and left elbow, right and left forearms, medial and lateral right and left wrists, right and left fingers, right and left ASIS and PSIS. Five postures were collected for three trials with a three-minute rest between each posture. The sequence of the postures was determined for 26 batches by a randomized sampling method and given to participants in sequence according to the order of enrollment. Kinematic data was collected using eight infrared cameras (Raptor-E, Motion Analysis Corporation, Santa, CA, USA) at the sampling rate of 100 Hz.

Data processing

Data was converted from analog to digital by Cortex software, Motion Analysis Corporation, Santa, CA, USA. Kinematic data was smoothed by Butterworth low-pass filtered at a cutoff frequency of 1 Hz, and EMG data was smoothed by Butterworth high-pass filtered at a cutoff frequency of 50 Hz and Butterworth lowpass filtered at a cutoff frequency of 500 Hz. The RMS values were normalized using the averaged MVIC amplitudes of each respective muscle. Visual 3D version 2020.08.3.

Data analysis

Descriptive statistics, mean, and standard deviations were performed using the PAWS statistics program (SPSS 18.0). Demographic data, joint kinematics, and muscle function were presented and reported.

RESULTS

Upper extremity joint movement in Ruesi Dutton

For cervical spine movement (Table 1), P4 was most active, followed by P3 in the left and right direction, and P2, P5. As for P1, there was very little movement on this axis. In the Y-axis (Table 2), there was lateral bending; and P3 in the right and left directions had the most movement. In the Z-axis (Table 3), P1 of the right and left rotation had the most movement, followed by the Kae Kiat posture in right and left direction, while the rest had little movement in this axis (not more than 10 degrees).

For thoracic spine movement (Table 1), the movement of P1, P3, P4, P5 was trunk flexion, and P5 had the most movement, followed by P3 in the left and right direction, P1, and P4, and P2 with movement in the form of trunk extension. In the Y-axis (Table 2), trunk movement was in the form of lateral bending and P5 had the most movement, followed by P1 and other postures without

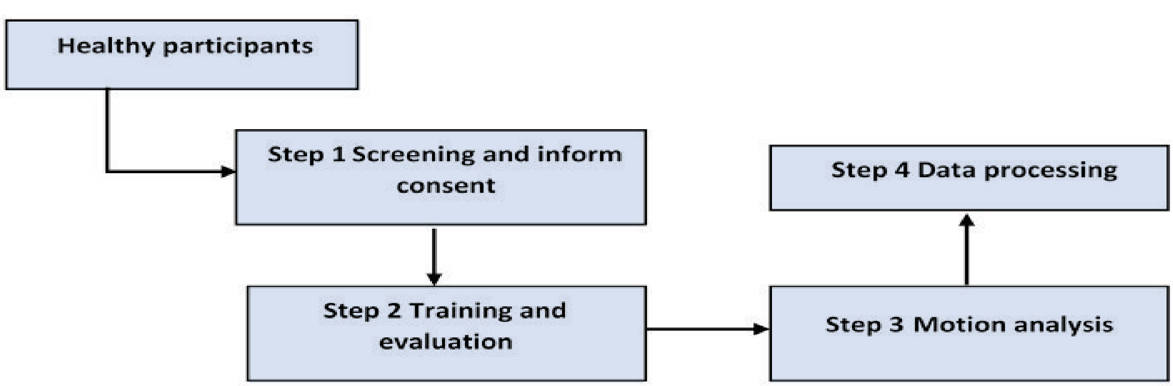

Fig 2. Flow chart of the study

TABLE 1. Sagittal plane joint angles.

Phase	Joint angle [Degrees (Mean±SD)] Neck	Trunk	Shoulders Rt.	Shoulders Lt.	Elbows Rt.	Elbows Lt.	Wrist Rt.	Wrist Lt.
P1 (Left)	5.40 ± 8.67	-14.04 ± 11.19	41.55 ± 10.45	10.29 ± 11.43	112.89 ± 9.49	129.97 ± 7.07	-21.62 ± 25.68	-42.83 ±38.93
P1 (Right)	2.96 ± 9.10	-13.61 ± 10.87	3.24 ±11.01	46.5 ±9.20	131.95 ±7.71	109.18 ± 8.53	-28.32 ±47.31	-32.66 ±25.82
P2	29.03 ±16.46	22.65 ±28.62	140.09 ±56.37	143.10 ±41.01	43.88 ±7.31	43.72 ±8.77	-15.85 ±9.01	-17.92 ±10.21
P3 (Left)	35.35 ±13.26	-29.13 ±15.94	98.57 ±8.71	104.89 ±8.82	21.52 ±9.43	19.51 ±9.37	14.68 ±32.39	12.84 ±32.01
P3 (Right)	33.50 ±13.61	-28.95 ±15.26	101.08 ±9.66	99.19 ±8.31	19.47 ±9.50	21.99 ±8.25	22.59 ±38.34	3.05 ±26.90
P3 (Upward)	14.40 ±12.81	-6.58 ±12.47	147.44 ±15.78	151.12 ±8.57	26.85 ±8.34	26.21 ±8.43	6.13 ±39.43	-8.79 ±29.26
P4	47.93 ±14.86	-11.76 ±13.89	-53.26 ± 50.00	-41.16 ± 51.99	88.65 ± 8.89	87.06 ± 8.44	-60.1 ± 19.80	-70.9 ± 12.94
P5 (LKLS)	15.22 ±7.88	-37.27 ±16.96	148.20 ±22.51	144.35 ±7.75	118.50 ±4.62	118.21 ±4.62	-57.45 ±10.20	-56.02 ±16.00
P5 (LKRS)	16.68 ±10.12	-37.43 ±17.16	139.43 ±63.26	144.72 ±8.29	121.65 ±5.09	116.52 ±4.87	-62.17 ±13.75	-51.04 ±12.78
P5 (RKLS)	16.68 ±11.61	-37.51 ±14.63	146.39 ±9.37	148.66 ±10.87	119.38 ±5.15	119.58 ±4.14	-55.58 ±10.61	-49.84 ±36.85
P5 (RKRS)	15.68 ±11.45	-38.08 ±15.02	142.25 ±16.77	147.95 ±9.58	121.81 ±5.16	117.67 ±4.86	-57.89 ±11.11	-52.46 ±16.08

Cervical and thoracic spine: X axis in (+) extension, (-) flexion, Right shoulder joint: X axis (+) forward flexion, (-) extension. Left shoulder joint: X axis (+) forward flexion, (-) extension, Right elbow joint: X axis (+) flexion, (-) extension, Left elbow joint; X axis (+) flexion, (-) extension, Right wrist: X axis (+) palmar flexion, (-) wrist dorsiflexion. Left wrist joint, X axis (+) palmar flexion, (-) wrist dorsiflexion. Kae Lom Kho Mue Posture (P1), Kae Puat Thong Kae Kho Thao Posture (P2), Kae Kiat Posture (P3), Kae Puat Thong Sabak Chom Posture (P4), and Kae Lom Puat Sisa Posture (P5)

TABLE 2. Frontal plane joint angles.

Phase	Joint angle [Degrees (Mean±SD)] Neck	Trunk	Shoulders Rt.	Shoulders Lt.	Elbows Rt.	Elbows Lt.	Wrist Rt.	Wrist Lt.
P1 (Left)	1.59 ±6.3	10.97 ± 5.22	-0.34 ± 11.05	30.70 ± 10.7	13.09 ± 8.85	-14.12 ± 5.88	-47.89 ±18.44	58.82 ±12.69
P1 (Right)	-3.23 ±7.96	-8.50 ±5.73	-31.84 ±10.57	-6.01 ±10.25	11.23 ±6.39	-22.95 ± 8.88	-63.47 ±16.53	45.99 ±12.81
P2	-1.36 ±3.37	1.28 ±1.70	-13.43 ±3.71	13.70 ±5.23	-6.90 ±7.19	4.05 ±6.23	-12.50 ±8.77	12.41 ±8.00
P3 (Left)	7.47 ±8.94	-4.23 ±7.17	9.81 ±8.86	22.27 ±11.90	-7.44 ±5.79	5.16 ±6.29	-51.06 ±14.36	57.25 ±15.29
P3 (Right)	-8.35 ±10.99	2.60 ±6.88	-23.86 ±14.49	-11.15 ±10.60	-8.81 ±5.64	2.78 ±6.95	-56.90 ±15.68	47.74 ±16.89
P3 (Upward)	-0.42 ±4.05	0.32 ±2.11	-14.72 ±4.59	13.98 ±5.70	-6.91 ±5.96	4.31 ±6.79	-55.76 ±16.97	56.95 ±14.00
P4	-0.94 ± 3.65	-0.83 ± 6.10	-70.68 ± 9.26	73.67 ± 8.82	-5.02 ± 7.68	6.7 ± 6.82	-37.68 ± 22.00	33.6 ± 17.77
P5 (LKLS)	-1.21 ±5.97	-17.99 ±9.56	-45.00 ±5.92	41.83 ±6.59	6.58 ±7.96	-10.20 ±6.42	-15.10 ±17.68	16.58 ±12.44
P5 (LKRS)	1.57 ±4.41	-17.51 ±10.08	-48.56 ±5.65	38.63 ±5.35	6.45 ±7.89	-9.63 ±6.83	-16.27 ±17.55	16.39 ±11.93
P5 (RKLS)	-0.51 ±4.07	17.74 ±10.51	-44.19 ±5.07	43.22 ±4.95	5.95± 7.93	-9.54± 6.83	-16.21 ±16.90	17.42 ±14.51
P5 (RKRS)	2.27 ±4.66	19.00 ±10.23	-47.11 ±5.54	39.87 ±4.83	6.29 ±7.83	-9.21 ±6.76	-17.01 ±16.75	14.37 ±11.34

Cervical and thoracic spine: Y axis (+) right tilt (-) left tilt, Right shoulder joint: Y axis (+) adduction and (-) abduction. Left shoulder joint: Y axis (+) abduction, (-) adduction. Right elbow joint: Y axis (+) medial tilt, (-) lateral tilt. Left elbow joint; Y axis (+) lateral tilt, (-) medial tilt. Right wrist: Y axis (+) ulnar deviation, (-) radial deviation. Left wrist joint, Y axis (+) radial deviation, (-) ulnar deviation. Kae Lom Kho Mue Posture (P1), Kae Puat Thong Kae Kho Thao Posture (P2), Kae Kiat Posture (P3), Kae Puat Thong Sabak Chom Posture (P4), and Kae Lom Puat Sisa Posture (P5)

TABLE 3. Transverse plane joint angles.

Phase	Joint angle [Degrees (Mean±SD)] Neck	Trunk	Shoulders Rt.	Shoulders Lt.	Elbows Rt.	Elbows Lt.	Wrist Rt.	Wrist Lt.
P1 (Left)	58.99 ± 12.61	34.76 ± 34.76	71.79 ± 11.86	-11.48 ± 19.97	70.32 ± 20.05	-70.22 ± 15.43	35.01 ±33.41	-30.76 ±35.47
P1 (Right)	-62.72 ± 13.81	-31.81 ±6.59	5.86 ±22.19	-65.79 ±14.02	67.21 ±20.93	-71.19 ±15.97	37.86 ±50.17	-24.63 ±19.34
P2	-0.40 ±5.08	-5.98 ±35.14	58.21 ±18.59	-54.72 ±13.45	62.72 ±16.25	-62.32 ±14.62	-4.97 ±15.97	5.88 ±12.67
P3 (Left)	10.37 ±9.79	26.16 ±14.06	72.92 ±17.52	-75.27 ±16.22	98.19 ±19.19	-110.60 ±24.74	90.33 ±35.34	-80.50 ±38.78
P3 (Right)	-12.73 ±12.65	-22.18 ±18.72	80.12 ±16.68	-65.56 ±17.09	95.33 ±22.66	-112.95 ±24.46	87.22 ±44.93	-68.76 ±32.84
P3 (Upward)	-0.71 ±4.89	1.45 ±2.97	82.08 ±18.43	-76.54 ±14.93	96.69 ±18.15	-109.22 ±18.90	82.41 ±39.00	-65.75 ±28.79
P4	-1.61 ± 5.43	1.8 ± 2.68	-102.49 ± 79.49	87.19 ± 78.29	71.33 ± 19.13	-70.56 ± 15.85	11.14 ± 21.70	-1.04 ± 11.10
P5 (LKLS)	-3.44 ±7.73	-4.59 ±5.08	70.58 ±15.68	-58.35 ±12.28	51.02 ±19.13	-49.43 ±16.12	-1.30 ±10.50	0.29 ±9.60
P5 (LKRS)	-6.53 ±7.58	-4.05 ±4.45	70.38 ±14.88	-57.42 ±11.43	50.57 ±19.44	-50.81 ±14.92	1.88 ±9.95	0.44 ±11.22
P5 (RKLS)	2.68 ±5.77	7.50 ±4.36	63.23 ±11.10	-61.68 ±13.10	50.65 ±19.56	-49.68 ±16.09	-1.98 ±9.77	-0.96 ±10.69
P5 (RKRS)	-0.54 ±6.03	8.17 ±4.75	61.70 ±12.11	-60.62 ±11.21	49.56 ±19.50	-50.06 ±15.63	-5.64 ±33.32	-1.71 ±9.63

Cervical and thoracic spine: Z axis (+), (-) right rotation. Right shoulder joint: Z axis (+) internal rotation, (-) external rotation. Left shoulder joint: Z axis (+) external rotation, (-) internal rotation. Right elbow joint: Z axis (+) internal rotation of arm, (-) external rotation of arm. Left elbow joint; Z axis (+) external rotation of arm, (-) internal rotation of arm. Right wrist: Z axis (+) pronation, (-) supination. Left wrist joint: Z axis (+) supination, (-) pronation. Kae Lom Kho Mue Posture (P1), Kae Puat Thong Kae Kho Thao Posture (P2), Kae Kiat Posture (P3), Kae Puat Thong Sabak Chom Posture (P4), and Kae Lom Puat Sisa Posture (P5) lateral bending. In the Z-axis (Table 3), the movement was in the form of trunk rotation and P1 and P3 in the right and left directions were very similar to those of the cervical spine.

The movement of the shoulder joint in the X-axis (Table 1) was in form of shoulder flexion in which P2, P5, and P3 in the upward direction had more than 140 - 180 degrees of movement whereas there were less than 100 degrees in other positions, and in P4 in the form of shoulder extension. In the Y-axis (Table 2), P4 and P5 saw the most extension of the arms whereas other postures had less than 40 degrees of extended arms. In the Z-axis (Table 3), most postures had an internal rotation of no more than 90 degrees, except for P4 which had an external rotation of greater than 100 degrees, which is higher than the degree of normal movement.

Elbow joint movement in the X-axis (Table 1) was elbow flexion, with the most flexion being P1, followed by P5, and other postures with no more than 90 degrees of flexion. In the Y-axis (Table 2), the medial till and lateral till, with very little movement, were no more than 15 degrees. In the Z-axis (Table 3), the medial rotation of the arm, with P3 had the most movement, whereas other postures did not move more than 70 degrees.

The movement of the wrist joints (Table 1) was in form of wrist extension, with P4 having the most movement, followed by P1, while other postures had movement of less than 50 degrees. In the Y-axis (Table 2), every posture was in form of radial deviation, and was most commonly found in P1, P3, P4 in which the degree was greater than normal, while other postures had movements less than 20 degrees. In the Z-axis (Table 3), P1, P3, P4 movement was in form of pronation wrist movement in which P3 had more than 80 degrees of movement while P2 and P5 were supinations, and not more than 20 degrees.

Muscle activation of upper extremities in Ruesi Dutton

P5 had the highest Biceps activity in the range of 12.54 - 14.40% MVIC, while other postures were in the range of 1.86 - 6.67% MVIC (Table 4). In the Triceps muscle, P3 had most muscle activity in the range of 19.53 – 32.67 %MVIC while other postures were in the range of 5.05-11.55% MVIC. In the Deltoids muscle, almost all postures had muscle activity in the range of 27.40 - 111.28% MVIC except for P1 which was in the range 3.94 - 10.82% MVIC. In the Lower Trapezius, P3 in the left and right directions, P5, P4, and P1 had muscle activity in the range of 78.73-121.33% MVIC while P4 and P3 in the upwards direction had muscle activities in the range of 30.01 - 48.87% MVIC. In the Middle Trapezius muscle, P4 had the greatest muscle activity in the range of 63.50 - 65.19% MVIC, followed by P1 had muscle activity in the range of 41.19 - 49.04% MVIC while other postures had muscle activity in the range of 4.56 - 32.88% MVIC. For the Upper Trapezius, P5 had the greatest muscle activity in the range of 74.93 - 83.25% MVIC, and P2 and P4 had similar muscle activity in the range of 55.26 - 59.45% MVIC, while P3 had muscle activity in the range of 32.71 - 47.13% MVIC and P1 had muscle activity in the range of 12.79 - 14.53% MVIC.

DISCUSSION

The primary objective of this study was to investigate upper extremity joint angles and muscle activity while performing select HDBC postures. To the authors' knowledge, this is the first study to fully describe 3D kinematic motion and muscle activation in HDBC. The movement of each joint had a range of motion within that joint's normal range[12-14] and in daily activity,[15-17] but there was more radial deviation and extension in the wrists. In addition, caution was taken in people who had injuries or disease around the wrist. However, these exercises may be more suitable for carpal tunnel syndrome, as they are similar to tendon gliding exercises18 and require care in the movement of the neck and shoulders in the elderly and those who are overweight. This is because in such cases, the degree of motion is reduced[14,19] and the external rotation angle of the shoulder is greater than the degree of normal movement so caution is necessary while performing these postures. Moreover, HDBC is recommended for patients with frozen shoulders due to the shoulder movement being greater than the range of motion of the disease.[20] Therefore, further studies may be needed.

From the study of muscle function, it was found that the relationship between the posture name and its benefits could not be clearly explained because it was a study of the superficial muscle function in the upper extremities only, and it did not look at the muscles related to the name of the posture. In P1, the Lower and Middle Trapezius muscles are used more than any other bundle which can reduce wrist pain from myofascial pain syndrome which has a trigger point at the shoulder and upper back.[21] However, EMG devices should be attached to pronator teres muscle, flexor, and extensor muscle group of the forearms and brachioradialis muscle because these muscles are directly related to wrist function. The lower and upper Trapezius have the most function in P2 but the benefits do not relate to the name of posture because the protocol for placing devices is not focused on proving the relationship. Therefore, EMG devices

TABLE 4. Muscle activity in Ruesi Dutton of upper extremities follows as; biceps, triceps, deltoid, upper trapezius, middle trapezius, and lower trapezius.

Posture		% MVIC (Mean±SD)											
		Biceps		Triceps		Deltoid		Lower trapezius		Middle trapezius		Upper Trapezius	
Name	Direction	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.
P1	Left	3.12	4.11	11.20	4.06	8.87	4.32	7.95	88.82	4.56	30.34	14.53	12.79
		±1.99	±2.71	±13.35	±1.60	±5.15	±3.07	±1.44	±52.10	±0.96	±17.40	±13.87	±11.21
	Right	3.90	3.20	5.40	5.65	10.82	3.94	86.92	15.15	31.67	8.41	14.16	12.80
		±2.95	±2.29	±4.55	±3.84	±7.96	±1.49	±49.20	±30.42	±17.04	±12.97	±12.89	±15.03
P2	-	4.13	4.31	12.04	8.71	81.01	40.32	30.01	35.0	16.93	16.72	55.26	54.57
		±2.21	±2.59	±6.74	±3.60	±42.52	±19.30	±32.14	±34.23	±12.72	±11.83	±37.57	±36.48
P3	Left	1.95	2.36	32.42	21.20	57.13	27.59	10.20	93.88	6.44	32.88	38.07	38.42
		±1.15	±1.48	±33.55	±12.74	±28.04	±13.79	±3.73	±54.37	±3.15	±19.37	±21.06	±23.22
	Right	1.86	2.34	28.73	19.53	50.20	27.40	121.33	12.64	31.86	8.68	40.46	32.71
		±1.02	±1.26	±19.40	±10.61	±22.23	±13.61	±72.56	±4.84	±18.94	±4.77	±21.17	±28.33
	Up	2.72	3.41	32.67	24.54	89.59	47.12	44.18	48.87	31.72	29.47	47.13	46.32
		±1.48	±2.09	±23.81	±13.32	±40.40	±19.23	±32.72	±43.43	±16.90	±15.72	±30.90	±33.78
P4	Front	4.03	6.67	11.39	11.55	78.25	45.79	87.62	102.09	65.19	63.5	58.95	59.45
		±3.39	±9.44	±6.86	±5.68	±32.03	±19.04	±37.53	±55.64	±32.10	±22.61	±43.45	±43.76
P5	LKLS	12.54	16.27	11.15	9.43	107.86	54.65	113.95	90.00	49.07	40.64	78.54	82.83
		±7.67	±10.95	±5.80	±4.02	±51.30	±21.04	±64.60	±43.83	±24.46	±16.53	±38.66	±50.52
	LKRS	14.40	14.64	10.52	9.15	111.28	53.81	111.53	89.58	48.64	41.19	80.94	83.25
		±8.34	±9.13	±5.51	±2.95	±53.10	±23.16	±49.96	±40.77	±23.16	±17.21	±42.39	±54.85
	RKLS	13.00	16.71	10.77	9.42	107.27	54.61	78.73	119.04	45.59	46.61	80.48	76.32
		±6.99	±10.17	±5.30	±3.82	±51.26	±22.03	±44.83	±55.12	±23.70	±15.82	±45.07	±51.83
	RKRS	13.62	14.03	10.05	9.14	103.86	52.59	82.81	109.72	42.78	44.86	81.15	74.93
		±6.82	±7.94	±5.47	±3.30	±49.57	±22.46	±51.83	±50.99	±21.59	±18.49	±47.48	±55.06

Kae Lom Kho Mue Posture (P1), Kae Puat Thong Kae Kho Thao Posture (P2), Kae Kiat Posture (P3), Kae Puat Thong Sabak Chom Posture (P4), and Kae Lom Puat Sisa Posture (P5) should be attached to the abdominal muscle and lower legs. P3 can reduce tiredness and laziness[4] according to the results and all the muscles had a function in the study. In P4, the three compartments of the Trapezius muscle have the most function which corresponds to the name of posture and benefits.[4] Moreover, there is also research on the use of this posture to treat and prevent myofascial pain syndrome at the scapular and shoulder.[5] In a further study, there must be an EMG device attached to the abdomen muscle. In P5, the muscles on the neck, shoulder, and upper back have functions that can help reduce tension-type headaches or myofascial pain syndrome[21-23] but there should be a further study to prove the efficiency and mechanisms.

In addition, the muscle function was close to 15 yoga postures.[24] The movement patterns of HDBC and asana yoga were found to have similar movement characteristics: to move the body in one position and hold still in the position for a period of time.[4,25] Therefore, the function of the muscles is working similarly. Moreover, in the Triceps muscle, 1/3 of a bench press exercise had a value greater than D1 flexion and scapular exercise.[26-27]

CONCLUSION

This study explains the pattern of joints movement and muscle activity of the Ruesi Dutton exercise which can be used as a guide in choosing appropriate postures for different conditions to ensure maximum efficacy and safety for practitioners and trainers. In addition, this data supports evidence of Thai Traditional medicine.

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