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A new hand dynamometer activforce isometric muscle activation on single joint muscle force of volleyball players

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Original article

Abstract

Isometric muscle activation of single joint to volleyball players is critic on sport performance to produce potential muscle force, however isometric measurement limited in isokinetic muscle activity measurement of volleyball players. Indeed, hand dynamometers commonly use in various body isometric force. Professional volleyball players age 16.23 ± 0.59 yr, body mass 60.22 ± 4.64 kg, hight 1.69 ± 0.04 m participated to peak and average isometric force measurement over 8 week pre and post test. Accordingly, single joint muscle force production measurement of volleyball players tested on isometric muscle activation using a new hand dynamometer activforce 2. Isometric muscle activation tests consisted of 24 body region from upper and lower compartment. For this isometric muscle action test detected on peak force outcomes (SEM: 37.90; CV: 1.79) and average force outcomes (SEM: 33.62; CV: 1.84). The high isometric muscle action joint loading performing mechanical test application recommended on athletic population to using isometric potential high contraction model by strength training performance separately in-season and off-season measurement modeling. Conclusion, peak and average force production progressive isometric modeling of volleyball athletes worked to current sport–health condition. As out, conclusion must be advanced isometric force measurement proper work in sport-specific tasks. The proper isometric force must be repeat sport performance outcome in different sport modalities.

Keywords

- isometric force
- peak
- average
- volleyball players

Contribution

A – Preparation of the research project
B – Assembly of data
C – Conducting of statistical analysis
D – Interpretation of results
E – Manuscript preparation
F – Literature review
G – Revising the manuscript

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Introduction

Isometric muscle action is a type of resistance training to production peak force reach, maximal strength as well as rapid force production.[1–3] Vital component to evaluate joint torque force of muscle compartment were pressure or strain changes to lead isometric muscle force.[4,5] In this case, muscular action by large muscle group perform varying force according to time-dependent isometric contraction combination.[2] Resistance loading may be force varying about isometric intensity at 1 RM 90%–100% or 2–4 second isometric contraction to reach maximal strength performance.[1–3] Similarity of muscular force performance reported to remained consant isometric peak reaches similarly other maximal performance outcomes. For resistance continuum, isometric action based on the range of motion is use static muscular force.[6] Furthermore, isometric muscle action periodized models to the rate of force development provided muscle dynamic activation associated with rapid force production.[2,5] As Comfort et al.,[3] the maximal and rapid isometric muscle force can be represent during unit training phase and intenses to evaluate as the common use of compartment multi joint setups conducted on increased peak and average force production at the given specific time-dependent. Andersen and Aagaard et al.[7] conducted for the contraction combination of the body force at a maximal peak force and a submaximal and average force. Indeed, force time curve to loading differences formed on isometric force transition by autoregulatory and autogenic properties as the joint range of motion and speed.[5,7] This situation generally elucidate during short and long time-dependent isometric rate of force development, also generating muscle force transiets derived from $F = (VN = k\gamma, k1, \ldots \text{Kiso})$, force production cycle (Force.50/ second.50) conducted to long time 5 s peak force and short time 1 s average force the joint range of motion of body mass.[5] The force complex of isometric contraction specified by muscle speed and strength/force also converted to $F = a/b$ called isometric force system where: a is peak muscle force and b is time in muscular rapid force production.[5] Thus, there where is time of isom energy production when performed from force peak or average time.[3] Isometric muscle activations obtained from the individual joint range of motion is actualized at body mass force characteristics.[7] Activforce hand dynamometer muscle isometric activations for time dependent forces may be normative data with normalized isometric peak and average forces to estimate is a valid and reliable method but limited information is avaible regarding of isometric force and gauge from professional volleyball players. Accordingly, avaible studies are inadequate and undervalue in i.e. isometric force action in regional activiation force. Thus, in this study two hypothetical rate of force development investigated on isometric peak and average force to obtain regional muscles addition force activation concluded as body mass and range of motion, while evaluation of isometric actions in volleyball players. The aim of study is to evaluate maximal force characteristic changes on between peak and average forces in professional volleyball players.

Materials and methods

Participation

Total 26 professional female volleyball players participated in this study. Volleyball players provided isokinetic muscle activity by all body regional muscle isometric force protocol. The volleyball players were age 16.30 ± 0.67 years, body mass 61.07 ± 6.61 kg, hight 1.71 ± 0.05 m physical characteristics. The experimental isometric force measurement processes evaluated in the sport laboratory. Permission from Akdeniz University Ethic Committee (890/220-2021) acceeded isometric force tests for the study.

Procedure

Isometric force measurement two months apart applied on upper and lower body regional force. The high intra to external rotation (0.95–0.98), internal rotation (0.97–0.98), forward elevation (0.96–0.99) and inter test to external rotation (0.85–0.96), internal rotation (0.95––0.97), forward elevation (0.88–0.95) intra correlation coefficient (ICC) values tested all motion.[9] Baseline and posttest measurements exacuated within one day for one volleyball players. Protocols of upper and lower body attention was paid to application in range of motion and motion stability. Standard dynamic warm-up 10 minutes applied before isometric muscle force conduction. Progressive protocol started from upper body 14 region then performed lower body 10 region as well as in supine, sit-up, prone positions. Total time to all body force given 20–30 minutes only for one volleyball player.

Activforce isometric muscle activation

Volleyball players performed isometric 2 hypothetical time-dependent and impulse experience in laboratory, state of isometric muscle contraction provided isometric peak and average force. A total 2.5 hours to individual testing was performed with isometric force 5 second peak and 1 second average force, fatigue providing an adequate 6 seconds time. Time-dependent maximal isometric in strength were evaluated in newton and body mass. To produce unit force in body mass was determined normalized isometric muscle force to peak and average force conducted $F_{normalize} = F$/body mass.[8] Isometric forces were measured in the Activforce system. Activforce 2 handheld dynamometer device (Activforce 2, Australia) was used to evaluate muscle activation. The system links a dynamometer with width 78 mm, length 95 mm and height 33 mm with software designed to assess a person's muscular strength. Muscle activations in isometric force allow us to obtain maximum muscle contraction and maximum strength based on the joint range of motion and body mass. Isometric dynamometer tests multiple to joint and limbs a valid measurement method for examining isometric muscle activation.[9,10]

Upper and lower compartment muscle strength was measured in 24 joint points (Table 1). All measurements were obtained proximal to the nearest joint. The movements were performed in sitting, supine and lying positions. Reference range of motion points: a) arm epicondyle proximal for shoulder flexion; b) shoulder extension; c) shoulder abduction; d) shoulder adduction; e) proximal styloid process for shoulder lateral/ internal rotation; f) shoulder medial/ external rotation; g) proximal styloid ridge for elbow flexion; h) elbow extension; i) proximal of the lateral styloid process of elbow supination; j) elbow pronation; k) proximal of the metacarpophalangeal joint for wrist flexion; l) wrist extension; m) wrist adduction; n) wrist abduction; o) hip flexion near the femoral epicondyle; p) hip extension; r) hip abduction near the lateral epicondyle; s) hip adduction; t) knee flexion proximal to malleoli; u) knee extension; v) dorsi flexion of the ankle proximal to the metacarpophalangeal joint; w) foot ankle plantar flexion; x) ankle inversion from proximal lateral malleoli and y) ankle eversion were determined in isometric muscle force activation.[9,10]

Table 1. Upper and lower compartment muscle strength procedures

Muscle compartment regions	Joint positions	Dynamometer placement	Stabilization
Shoulder flexion	Shoulder flexed 90°, elbow extended	Just proximal to epicondyles of humerus	Axillary region
Shoulder extension	Shoulder flexed 90°, elbow extended	Just proximal to epicondyles of humerus	Superior aspect of shoulder
Shoulder abduction	Shoulder abducted 45°, elbow extended	Just proximal to lateral epicondyle of humerus	Superior aspect of shoulder
Shoulder adduction	Shoulder adduction 45°, elbow extended	Just proximal to medial epicondyle of humerus	Superior aspect of shoulder
Shoulder lateral rotation	Shoulder abducted 45°, elbow at 90°	Just proximal to styloid processes	Elbow
Shoulder medial rotation	Shoulder abducted 45°, elbow at 90°	Just proximal to styloid processes	Elbow
Elbow flexion	Shoulder at neutral; elbow flexed 90°, forearm supinated	Just proxiaml to styloid processes	Superior aspect of arm
Elbow extension	Shoulder at neutral; elbow flexed 90°, forearm neutral	Just proximal to lateral styloid processes	Anterior aspect of arm
Elbow supination	Shoulder at neutral; elbow flexed 45°, forearm supinated	Just proximal to lateral styloid processes	Lateral aspect of arm
Elbow pronation	Shoulder at neutral; elbow flexed 45°, forearm pronated	Just proximal to lateral styloid processes	Medial aspect of arm
Wrist flexion	Shoulder at neutral; elbow flexed 90°, wrist flexed	Just proximal to metacarpophalangeal joints	Distal forearm

Muscle compartment regions	Joint positions	Dynamometer placement	Stabilization
Wrist extension	Shoulder at neutral; elbow flexed 90°, wrist neutral	Just proximal to metacar-pophalangeal joints	Distal forearm
Wrist adduction	Shoulder at neutral; elbow flexed 90°, wrist adducted	Just proximal to metacar-pophalangeal joints	Distal forearm
Wrist abduction	Shoulder at neutral; elbow flexed 90°, wrist abducted	Just proximal to metacar-pophalangeal joints	Distal forearm
Hip flexion	Hip flexed at 90°; knee relaxed; contralateral hip in neutral	At femoral epicondyle	Pelvis
Hip extension	Hip extended at 90°; knee relaxed; contralateral hip in neutral	At femoral epicondyle	Pelvis
Hip abduction	Hip abducted at 120°; knee relaxed; contralateral hip in neutral	At medial femoral epicondyle	Pelvis
Hip adduction	Hip adducted at 120°; knee relaxed; contralateral hip in neutral	At lateral femoral epicondyle	Pelvis
Knee flexion	Hips and knees flexed at 90°	Just proximal to malleoli	Stabilized at hip
Knee extension	Hips and knees extended at 90°	Just proximal to malleoli	Stabilized at hip
Ankle dorsi flexion	Hip, knee and ankle at 0°	Just proximal to metatarso-phalangeal joints	Knee full extended
Ankle plantar flexion	Hip, knee and ankle at 0°	Just proximal to metatarso-phalangeal joints	Knee full extended
Ankle inversion	Hip, knee at 0°; ankle inversion	Just proximal to metatarso-phalangeal joints	Knee full extended
Ankle eversion	Hip, knee at 0°; ankle eversion	Just proximal to metatarso-phalangeal joints	Knee full extended

Statistical analysis

The statistical data were analyzed using SPSS 22.0 for Windows (SPSS Inc., Chicago, Illinois, US). All data were presented pre-intervention to evaluate normal distribution by the Shapiro-Wilk test. Population pre- and post-intervention mean and standard deviation obtained from confidence interval (CI 95%) to detect calculation effect size = 0.75, α error probability = 0.5 and power (1 – β) error probability = 0.95 transferred by G*Power software (v3.1.9.7; Heinrich-Heine-Universitat Duesseldorf, Duesseldorf, Germany; http://www.gpower.hhu.de) analysis.[10] The effect of the time point (baseline and posttest) was evaluated using a Paried *T*-test in a sample of volleyball players. The SEM was calculated using the formula: SD (pooled) × $\sqrt{1-\text{ICC}}$. The absolute relatively study risk solved coefficient of variance $CV = \sigma/\mu$. Result CV risk ratios explained <1 low, 1 to 2 intermediate and 2 to 3 high and >3 very high in this study. An a priori alpha level was set at $p < 0.05$. The changes significant descriptors were Hedges' g effect size with confidence intervals were used to effect size: <0.20 – trivial, 0.21–0.60 – moderate, 0.61–1.20 – large, 1.21–2.0 – very large.

Results

The peak and average time-dependent force changes and normalized-allometric peak and average force indicated in activforce muscle isometric activation over 4 weeks. To detect normalize isometric peak and average force changes provided upper and lower body compartment muscle force by body mass. To determine different upper and lower body compartment muscle isometric forces were specified shoulder, elbow, wrist, hip, knee and ankle region evaluation in volleyball players.

Table 2. Isometric peak muscle force changes

Isometric movements	Test	Mean ± SD	CI 95% Lower – Upper	SEM	CV
Shoulder flexion	Pre Post	103.55 ± 22.80 N 129.09 ± 17.95 N	(−36.82) – (−14.25)	39.23	1.09
Shoulder extension	Pre Post	98.35 ± 22.35 N 143.51 ± 32.44 N	(−58.06) – (−32.24)	44.44	0.70
Shoulder abduction	Pre Post	109.87 ± 26.22 N 134.56 ± 22.14 N	(−35.17) – (−14.21)	35.57	1.05
Shoulder adduction	Pre Post	91.84 ± 22.78 N 137.52 ± 20.69 N	(−56.84) – (−34.51)	39.05	0.60
Shoulder lateral/internal rotation	Pre Post	104.93 ± 36.58 N 152.76 ± 32.86 N	(−63.17) – (−32.49)	53.65	0.79
Shoulder medial/external rotation	Pre Post	87.86 ± 21.18 N 122.18 ± 21.33 N	(−45.75) – (−22.88)	40.01	0.82
Elbow flexion	Pre Post	130.59 ± 34.01 N 149.07 ± 41.08 N	(−34.11) – (−2.83)	54.51	2.09
Elbow extension	Pre Post	113.78 ± 33.99 N 166.61 ± 30.09 N	(−69.03) – (−36.62)	56.39	0.75
Elbow supination	Pre Post	86.03 ± 22.40 N 130.71 ± 36.95 N	(−61.07) – (−28.27)	52.40	0.90
Elbow pronation	Pre Post	111.02 ± 37.07 N 123.57 ± 33.38 N	(−27.71) – (2.62)	39.94	2.99
Wrist flexion	Pre Post	87.18 ± 22.20 N 106.69 ± 24.41 N	(−28.72) – (−10.30)	22.23	1.16
Wrist extension	Pre Post	78.20 ± 19.35 N 82.74 ± 19.67 N	(−14.41) – (5.34)	34.59	5.39
Wrist adduction	Pre Post	69.02 ± 19.01 N 102.21 ± 18.86 N	(−43.05) – (−23.31)	31.54	0.73
Wrist abduction	Pre Post	90.66 ± 34.01 N 112.56 ± 33.69 N	(−40.87) – (−2.92)	65.19	2.14
Hip flexion	Pre Post	149.73 ± 37.89 N 203.69 ± 37.00 N	(−74.24) – (−33.68)	67.32	0.93
Hip extension	Pre Post	139.73 ± 57.68 N 239.38 ± 50.24 N	(−126.82) – (−72.46)	83.53	0.67
Hip abduction	Pre Post	121.97 ± 35.85 N 168.24 ± 38.86 N	(−61.36) – (−31.18)	37.28	0.80
Hip adduction	Pre Post	110.20 ± 20.67 N 175.72 ± 44.23 N	(−85.06) – (−45.96)	63.79	0.73
Knee flexion	Pre Post	133.57 ± 31.13 N 195.40 ± 47.95 N	(−85.24) – (−38.42)	−56.93	0.93
Knee extension	Pre Post	172.75 ± 50.88 N 176.59 ± 46.35 N	(−24.43) – (16.75)	53.37	13.31
Ankle dorsi flexion	Pre Post	91.59 ± 27.54 N 123.91 ± 27.31 N	(−43.75) – (−20.88)	29.18	0.87
Ankle plantar flexion	Pre Post	77.08 ± 16.28 N 122.49 ± 27.32 N	(−59.34) – (−31.47)	−39.55	0.75
Ankle inversion	Pre Post	81.77 ± 16.93 N 103.88 ± 17.72 N	(−31.89) – (−12.31)	38.27	1.09
Ankle eversion	Pre Post	84.51 ± 19.59 N 97.82 ± 21.24 N	(−22.39) – (−4.21)	24.74	1.69

N – Newton; $p \leq 0.05$

Isometric muscle activation results baseline and posttest to peak force production were detected shoulder flexion ($t = -4.659$; $p = 0.000$; $ES = 1.24$) shoulder extension ($t = -7.202$; $p = 0.000$; $ES = 1.62$), shoulder abduction ($t = -4.851$; $p = 0.000$; $ES = 1.01$), shoulder adduction ($t = -8.425$; $p = 0.000$; $ES = 2.09$), shoulder lateral/internal rotation ($t = -6.421$; $p = 0.000$; $ES = 1.37$) and shoulder medial/external rotation ($t = -6.183$; $p = 0.000$; $ES = 1.61$). For elbow flexion determined ($t = -2.433$; $p = 0.022$; $ES = 0.49$), elbow extension ($t = -6.713$; $p = 0.000$; $ES = 1.64$), elbow supination ($t = -5.609$; $p = 0.000$; $ES = 1.46$) and elbow pronation ($t = -1.703$; $p = 0.101$; $ES = 0.35$). For baseline and posttest were detected wrist flexion ($t = -4.363$; $p = 0.000$; $ES = 0.83$), wrist extension ($t = -0.946$; $p = 0.353$ $ES = 0.23$), wrist adduction ($t = -6.923.$; $p = 0.000$; $ES = 1.75$) and wrist abduction ($t = -2.377$; $p = 0.025$; $ES = 0.64$). For baseline and posttest were detected hip flexion ($t = -5,481$; $p = 0.000$; $ES = 1.44$), hip extension ($t = -7.550$; $p = 0.000$; $ES = 1.84$), hip abduction ($t = -6.315$; $p = 0.000$; $ES = 1.23$) and hip adduction ($t = -6.902$; $p = 0.000$; $ES = 1.89$). Baseline and posttest measurement detected knee flexion ($t = -5,439$; $p = 0.000$; $ES = 1.52$), knee extension ($t = -0.384$; $p = 0.704$; $ES = 0.07$). For baseline and posttest measurement were detected ankle dorsi flexion ($t = -5.822$; $p = 0.000$; $ES = 1.17$), ankle plantar flexion (t = 6.711; $p = 0.000$; $ES = 2.01$), ankle inversion ($t = -4.650$; $p = 0.000$; $ES = 1.27$) and ankle eversion ($t = -3.014$; $p = 0.006$; $ES = 0.65$).

Table 3. Isometric average muscle force changes

Isometric movements	Test	Mean ± SD	CI 95% Lower – Upper	SEM	CV
Shoulder flexion	Pre Post	83.21 ± 18.93 N 106.51 ± 14.44 N	(−31.48) – (−15,10)	24.19	0.87
Shoulder extension	Pre Post	83.26 ± 19.02 N 112.04 ± 20.51 N	(−38.48) – (−19.06)	29.17	0.83
Shoulder abduction	Pre Post	91.90 ± 22.93 N 111.45 ± 22.11 N	(−29.37) – (−9.71)	26.25	1.24
Shoulder adduction	Pre Post	73.44 ± 18.52 N 112.78 ± 16.54 N	(−46.80) – (−31.86)	19.42	0.46
Shoulder lateral/ internal rotation	Pre Post	82.22 ± 26.22 N 124.34 ± 31.36 N	(−56.33) – (−27.89)	42.66	0.83
Shoulder medial/ external rotation	Pre Post	73.45 ± 18.33 N 100.98 ± 15.16 N	(−36.75) – (−18.30)	0.02	0.82
Elbow flexion	Pre Post	104.49 ± 26.85 N 121.10 ± 31.70 N	(−30.06) – (−3.14)	27.72	2.00
Elbow extension	Pre Post	92.48 ± 27.88 N 136.60 ± 25.84 N	(−58.90) – (−29.33)	49.79	0.82
Elbow supination	Pre Post	70.85 ± 16.34 N 110.46 ± 30.70 N	(−54.06) – (−25.14)	18.81	0.90
Elbow pronation	Pre Post	88.41 ± 26.46 N 105.67 ± 30.84 N	(−29.45) – (−5.06)	31.62	1.74
Wrist flexion	Pre Post	74.16 ± 20.92 N 92.99 ± 23.10 N	(−27.59) – (−10.06)	21.30	1.15
Wrist extension	Pre Post	64.07 ± 15.54 N 68.08 ± 16.61 N	(−12.98) – (4.96)	30.63	5.53
Wrist adduction	Pre Post	57.35 ± 15.95 N 84.41 ± 17.30 N	(−35.31) – (−18.80)	25.07	0.75
Wrist abduction	Pre Post	76.61 ± 26.90 N 95.20 ± 27.43 N	(−33.90) – (−3.28)	52.86	2.03
Hip flexion	Pre Post	125.48 ± 31.83 N 167.95 ± 23.01 N	(−56.54) – (−28.40)	43.10	0.81
Hip extension	Pre Post	110.91 ± 39.57 N 185.22 ± 44.98 N	(−98.82) – (−49.79)	82.35	0.81

Isometric movements	Test	Mean ± SD	CI 95% Lower – Upper	SEM	CV
Hip abduction	Pre Post	102.22 ± 34.92 N 133.25 ± 32.45 N	(−42.71) – (−19.34)	24.79	0.93
Hip adduction	Pre Post	92.49 ± 18.25 N 137.36 ± 37.67 N	(−60.97) – (−28.76)	50.77	0.86
Knee flexion	Pre Post	111.30 ± 26.17 N 157.29 ± 39.65 N	(−67.61) – (−24.35)	47.98	1.16
Knee extension	Pre Post	142.75 ± 42.95 N 139.76 ± 33.36 N	(−14.41) – (20.38)	47.84	14.45
Ankle dorsi flexion	Pre Post	73.85 ± 19.83 N 108.75 ± 26.80 N	(−45.13) – (−24.65)	26.95	0.72
Ankle plantar flexion	Pre Post	58.97 ± 14.88 N 103.99 ± 23.46 N	(−56.72) – (−33.30)	34.92	0.66
Ankle inversion	Pre Post	68.16 ± 14.77 N 82.88 ± 17.35 N	(−23.23) – (−6.21)	27.46	1.43
Ankle eversion	Pre Post	70.72 ± 18.32 N 78.19 ± 14.70 N	(−15.10) – (0.15)	21.36	2.52

N – Newton; $p \leq 0.05$

Isometric muscle activation results baseline and posttest to peak force production were detected shoulder flexion ($t = -5.857$; $p = 0.000$; $ES = 1.38$) shoulder extension ($t = -6.104$; $p = 0.000$; $ES = 1.45$), shoulder abduction ($t = -4.094$; $p = 0.000$; $ES = 0.86$), shoulder adduction ($t = -10.850$; $p = 0.000$; $ES = 2.24$), shoulder lateral/internal rotation ($t = -6.100$; $p = 0.000$; $ES = 1.45$) and shoulder medial/external rotation ($t = -6.149$; $p = 0.000$; $ES = 1.63$). For elbow flexion determined ($t = -2.540$; $p = 0.018$; $ES = 0.56$), elbow extension ($t = -6.146$; $p = 0.000$; $ES = 1.64$), elbow supination ($t = -5.641$; $p = 0.000$; $ES = 1.61$) and elbow pronation ($t = -2.915$; $p = 0.007$; $ES = 0.60$). For baseline and posttest were detected wrist flexion ($t = -4.427$; $p = 0.000$; $ES = 0.85$), wrist extension ($t = -0.921$; $p = 0.366$; $ES = 0.24$), wrist adduction ($t = -6.750$; $p = 0.000$; $ES = 1.62$) and wrist abduction ($t = -2.501$; $p = 0.019$; $ES = 0.68$). For baseline and posttest were detected hip flexion ($t = -6.219$; $p = 0.000$; $ES = 1.52$), hip extension ($t = -6.242$; $p = 0.000$; $ES = 1.75$), hip abduction ($t = -5.468$; $p = 0.000$; $ES = 0.92$) and hip adduction ($t = -5.737$; $p = 0.000$; $ES = 1.51$). Baseline and posttest measurement detected knee flexion ($t = -4.378$; $p = 0.000$; $ES = 1.36$), knee extension ($t = 0.354$; $p = 0.727$; $ES = 0.07$). For baseline and posttest measurement were detected ankle dorsi flexion ($t = -7.018$; $p = 0.000$; $ES = 1.48$), ankle plantar flexion ($t = -7.918$; $p = 0.000$; $ES = 2.29$), ankle inversion ($t = -3.564$; $p = 0.002$; $ES = 0.91$) and ankle eversion ($t = -2.017$; $p = 0.055$; $ES = 0.44$).

Table 4. Changes in normalized isometric muscle peak and average force

Isometric movements	NPF $N \cdot m_b^{-1}$		NAF $N \cdot m_b^{-1}$	
	Mean		Mean	
	Pre	Post	Pre	Post
Shoulder flexion	1.69	2.11	1.36	1.74
Shoulder extension	1.61	2.34	1.34	1.83
Shoulder abduction	1.79	2.20	1.50	1.82
Shoulder adduction	1.50	2.25	1.20	1.84
Shoulder lateral/ internal rotation	1.71	2.50	1.34	2.01

Isometric movements	NPF $N \cdot m_b^{-1}$		NAF $N \cdot m_b^{-1}$	
	Mean		Mean	
	Pre	Post	Pre	Post
Shoulder medial/external rotation	1.43	2.00	1.20	1.65
Elbow flexion	2.13	2.44	1.71	1.98
Elbow extension	1.86	2.72	1.51	2.23
Elbow supination	1.40	2.14	1.16	1.80
Elbow pronation	1.81	2.02	1.44	1.73
Wrist flexion	1.42	1.74	1.21	1.52
Wrist extension	1.28	1.35	1.04	1.12
Wrist adduction	1.13	1.67	0.93	1.38
Wrist abduction	1.48	1.84	1.25	1.55
Hip flexion	2.45	3.33	2.05	2.75
Hip extension	2.28	3.91	1.81	3.03
Hip abduction	1.99	2.75	1.67	2.18
Hip adduction	1.80	2.87	1.51	2.24
Knee flexion	2.18	3.19	1.82	2.57
Knee extension	2.82	2.89	2.33	2.28
Ankle dorsi flexion	1.49	2.02	1.20	1.78
Ankle plantar flexion	1.26	2.00	0.95	1.70
Ankle inversion	1.33	1.70	1.11	1.35
Ankle eversion	1.38	1.60	1.15	1.28

NPF – normalized peak force; NAF – normalized average force

Discussion

Muscle force activations in isometric action and loading provided regional force development. However, exercise and training types target different isometric force changes by producing isometric action and static range of motion. Isometric muscle contraction to determine peak and average force on time-dependent force characteristics specified early and late isom maximal peak reaches similarly maximal strength or strength speed force-time curves.[5] Early peak isom ranges generally is shown maximal isometric strength and late peak isom ranges is shown explosive strength.[2] In this case, high and low load volleyball training experiences and training loading may be propered different large and small muscle group static strength. Muscular strength changes over 4 weeks obtained low-high maximum effort to isometric actions, thus upper and lower body actualized to composed muscular isometric force in regional muscle coordination relationship peak force.[3] The isometric action and resistance training were in peak and average force production during isometric contraction. The upper body and lower body peak and average force are a combination isometric actions. Isometric action was displayed on range of motion in different movement range.[10] For this study muscular isometric activation was used a effective isometric movement models and measurement methods to evaluate isom peak reach force of volleyball players. There were a combination of range of motion for upper and lower body movement characteristics and to determine time-dependent maximal isometric eforts of upper and lower body movements.[10] Although, there were significantly differences according to 2 months isometric force measurement and a difference variations were obtained baseline and posttest measurement. In this case, it is thought that maximal muscle force will be determined through isometric action by general body movements. Unlike, exercise and training no experience any force changes in short-term protocols, and it caused a change in isometric muscle activation with strength development especially in early average force and late peak force on chronic effects. Thus, isometric forces fulfill on new handheld device activforce 2 dynamometer for joint torque sequences of muscle activation identified peak and average force from two strain impulse gauge limitation. Maximal isometric force rate of force development obtained peak and average force split.[3] These results from measurement implicate in volleyball players evaluated isometric force generation by general body force analysis produced from body mass and range of motion were related to 24 region force difference.[10] However, activforce muscle isometric force outcomes only shoulder region was showed a limitation. Furthermore, the isometric time-dependent force to upper and lower regions relationship between joint force transition and rate of force development in the other population needs to be investigated further will future studies. These isometric force can be used for other athletes with difference exercise or training sections.

Conclusion

Time-dependent isometric force section to joint force transition and rate of force development provided in isometric protocol. We found 2 hypothetical impulse response repeated measurement based on long and short time isometric force by handheld dynamometer index scores, obtained by sport coaches during two test session of 26 volleyball athletes, to be low relatively risk. Handheld dynamometer may be considered between joint range of motion and muscle force section relationship under force transient to isometric forces changes. However, the limitation of the study was only indices in the isometric 24 region muscle coordination.

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