Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2013, 5(12):77-82

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Relative analysis of shoulder and elbow common sports injury kinematics parameters in volleyball spike

Fei Dong

Department of Basic Courses, Henan Mechanical and Electrical Engineering College, Xinxiang, China

---

ABSTRACT

Volleyball is a kind of widespread, mass base sports item, which also extensive developed as a competitive sports program in every college and university, has strong antagonism, big exercise intensity ,and quick transition between attack versus defense so on other sports features. Athletes would easily suffer all kinds of sports injury if improper methods applied into teaching, training and competitions. This paper mainly studied the connection between college volleyball players spike process and common positions sports injury. Firstly, utilize high speed image analysis techniques to get kinematic parameters, and then combine with sports biomechanics principle and statistical analysis method to make research on the spike process of our schools major spikes that long-term engaged in volleyball ,try to find out the common features and key caused that lead to injury as well as provide corresponding improvement suggestions. Research results show that shoulder and elbow as well as surrounding muscles injury most happened in spiking process, while the main cause to the injure is shoulder abduction angle in push moment and elbow maximum abduction angle in touch moment. At last, put forward some improvement suggestions to provide some theoretical proofs and references for optimizing volleyball sports basic theory, improving college volleyball training methods, reducing sports injury and enhancing sports performance.

Key words: Volleyball sport, spike techniques, sports injury

INTRODUCTION

Sports injury refers to all kinds of injury occurred to sports movements, especially the injury related to technical motions in sports items. The sports injury ,it will effect on athlete's athletic ability and performance as the best, while even cause wounded ,deformed as the worst, has an impact on sports life and daily life. The occurrence of sports training and sports injury cannot be avoided in every sports, training propel athletes athletic ability and performance, while in the meanwhile ,improper and excessive training, mistakable technical motions and exercise habits would easily cause injury. In competition, because of violently fighting, some accidents might not be avoided; but in daily training, the injury can be reduced or avoided through scientific and proper arrangement. Volleyball is a kind of intensive, strong antagonistic, quick attack versus defense transition sports item that strict with every position of human body's strength and coordination. If improper training, multiple positions would easily get injured [1].

Through investigation of long-term volleyball teaching, training and competitions as well as multiple volleyball coaches and athletes engaged in this movement, it can be acknowledged that many athletes suffer sports injury in shoulder, waist, knees, ankle and finger so on other positions to some different degrees among which most are closed soft tissue injuries, such as muscle contusion, ligaments, joint sprain etc. [2], while also few opened soft tissue bruises occurred. Besides, different team position also effect on vulnerable positions, like main attack and minor attack players shoulder, elbow and wrists obviously occupied larger injured proportion than other positions. By consulting a great many references, the writer find that though many researches on volleyball sports injury at home and abroad, less sports injury research specified to some specific location on site or on specified stage such as spike [3]. So far every volleyball coach in college and athletes care about the unnecessary sports injury preventing and sports injury occurrence ratio reduction. Spike as volleyball's major attacking and scoring method, also the last link

of tactic cooperation in each round, it normally regarded the emphasis in the training by considering its special status. And spike's explosive push procedure enable it the major attack method, while meanwhile bring great force to athlete every positions [4]. Sports injury is very easy generated by improper motions.

This paper mainly studies the relationship between college volleyball athletes spike techniques and sports injury, by analyzing volleyball players primarily trained spiking techniques, tries to find out the relationship between college volleyball athletes common sports injury and common issues existing on spiking techniques, and on this basis put forward improvement suggestions, furthermore improve our school's volleyball athletes sports performance, perfect training method, provide reference to spread volleyball as well as the overall college volleyball sports development. Meanwhile, prevent and avoid the occurrence of sports injury, extend athletes sports life, better bring its sports health building function into play, well exhibit volleyball's fascination.

EXPERIMENTAL SECTION

Research Method: Main research method in this paper including documentary method, observation method, high speed photography method, image analytical method and mathematical statistics so on. High speed photography is used for data collecting, that is to adopt two JVC GR-DVL9800SH high speed cameras at 110ºangle to carry out 3D synchronization fixed point shooting (100 frames/second) with sports process, get athletes technical motion images in training and competition, then use APAS SYSTEM 2003 sports analytical system to analysis sports process images, get athletes kinematic parameters in spiking process. Sample size set at 8 and 3 times measurement carried out so as to ensure validity and accuracy of research results. Professional statistics analysis software SPSS 15.0 is used to do data handling, which makes statistical analysis to every groups sample data and do research on correlation of every parameters, significance level usually select 0.05.

According to volleyball features and relative documentary data, main kinematic index and research objects physical index that got in this paper as below Table 1 shows.

Table 1：Main research index

index	Content
Kinematic index	1.Every stages duration in spiking process 2.Every body part spatial position in spiking process 3.Every body part speed, accelerated speed in spiking process 4.Every body part posture angle, joint angle in spiking process
Physical index	1.height 2.training year 3.sports injure status

Research objects: The selected research objects in this paper are 8 our schools' professional man athletes, positions as main attack, all are first grade provincial athletes, its basic information as below Table 2 shows.

Table 2：Research objects basic information

No.	Age	Height	Training year	Sports injury type &position		
				Muscle strain	Joint sprain	strain
1	22	184.2	6	Waist and back		Waist and Back ,elbow, knees
2	21	187.3	5		shoulder；	shoulder； knees； ankle；
3	23	185.2	6	Ankle	Finger and wrist；	Shoulder ,elbow, ankle
4	21	182.4	5		Waist and back；	Waist and back； elbow； ankle
5	20	186.5	7	elbow；	Finger and wrist	Waist and back； shoulder；
6	22	188.2	6	ankle；	elbow；	Waist and back； elbow； ankle；
7	23	181.0	7	elbow；		Waist and back； shoulder；
8	23	183.6	5		shoulder；	shoulder； elbow； knees；

The average height of 8 research objects is 184.8cm. As a main attack, height is one of the important factors that impact on spiking height. Besides, the average volleyball training year of 8 research objects arrive 6 years and more ,obviously indicates long term engaged in volleyball ,formed its own sports techniques and features, its kinematic trail may have some deeper connection with their sports techniques and habits. In addition, these 8 research objects have strain and injury in waist back, shoulder, elbow, wrist and so on because of long-term volleyball training ,which is related to their spiking techniques, spiking habits , and some technical flaws and bad habits will furthermore be the potential factors worsen every part injury.

The survey of 8 research objects shows that due to student athletes sports duration and intensity are quite smaller than that of professional athletes, training and competition intensity far weaker than that of professional athletes, acute damage as ligament torn, joint sprain less happened to them whose injury major in strain that account for 70%

of total injury. Except for sports itself, bad habits and unscientific action are inseparable caused these strain. Injury part mainly concentrate on waist, knees, and shoulder so on, it closely related to volleyballs own features. Relative information shows that due to lots of motions as stop, jump, turn, diving save and land should be made, volleyball athlete's knees and ankle become easily injured position. In addition, athletes that attack different positions on the courts, their vulnerable injury parts have own features. This paper mainly studies relationship between spiking motion and sports injury, all the research objects are major attacker, therefore mainly discuss the linkage between spiking techniques and injury of athletes vulnerable injury part as shoulder, elbow etc.[5].

Selection of kinematic parameters caused sports injury in spiking process: Spiking motion is a movement that complete in succession, which every body part cooperate and influence with each other in the whole process. The whole motion's completing process normally can be divided into 4 segments as run, jump, spike and land, previous segment completing will directly influence on the next one. Every segment mistake types in unscientific spiking process can be divided into two types-primary mistake generated by the segment itself and secondary mistake caused by process effects from previous segment. Only find out these mistakes root cause and correct, sports injury can be fundamentally prevented. This paper combines with spiking process every segments feature, select every stages time differences, each posture angle, joint angle and other human body kinematic parameters as the research evidence of the links between spiking process and sports injury.

Kinematic analysis of relation between spiking process and every part injury

Does every sport should follow human body muscle and every joints motion law? Once violated the law, muscle and joints would endure great stress, while the stress once beyond the tolerance or accumulated to a certain extent, it will cause sports injury. This paper use analysis and comparison of volleyball athletes spiking process every segments maximum kinematic parameters, make research on its causes to every part sports injury.

Shoulder injury research: The last and most important segment in spiking process is hit in the air, in which shoulder is the leading push joint and also the long-term spiking vulnerable joint. This paper would break down spiking process, respectively record the time frame of jump off the ground moment, maximum stretch arm moment, hitting moment and landing moment, firstly analysis duration of motion completing's effect on shoulder injury. Observational data as following Table 3 shows.

Table 3：Spiking process every moment completion time(s)

No.	Jump off the ground moment	Maximum stretch arms moment	Hitting moment	Landing moment
1	1.17	1.51	1.56	1.85
2	1.12	1.34	1.45	1.76
3	1.09	1.23	1.47	1.67
4	1.19	1.47	1.58	1.85
5	1.03	1.25	1.42	1.73
6	0.91	1.07	1.19	1.52
7	1.05	1.21	1.33	1.68
8	1.10	1.28	1.41	1.70
Average value	1.08	1.30	1.43	1.72
Standard deviation	0.06	0.11	0.09	0.08

Data in Table 3 shows that average time of research objects from jump to maximum stretch arm moment is 0.22s,from maximum stretching arms to hitting moment is 0.13s,while that from complete hitting moment to landing is 0.29s.And overseas research results show that world first-rate men volleyball players first two items average time intervals are respectively 0.158s and 0.192s.It indicates research objects take long hold time in arms stretching ,that would increase shoulder and surrounding ligament muscle burden under stress state for long time; while swing arms and hitting take short time, short time accumulated energy releasing from shoulder and muscle also raise the chance of injury.

Table 4： Comparison of every posture angle in push moment

	Horizontal stretch angle		Rotation exterior angle		Abduction angle	
	Injured group	Uninjured group	Injured group	Uninjured group	Injured group	Uninjured group
Minimum value	45.61	61.20	32.24	36.91	132.25	109.52
Maximum value	88.46	87.33	87.45	88.54	162.24	128.35
Range	43.85	26.13	55.21	51.63	29.99	18.83
Average value	72.21	74.10	62.25	66.43	146.51	117.23
Standard deviation	11.33	12.32	17.60	20.58	7.85	10.62

Except that motion completion time caused shoulder injury in hitting process, completion posture has more connection to such injury, it mainly reflected in upper arms horizontal stretch angle, rotation exterior angle and

abduction angle in hitting. In order to perfectly find out above 3 angles correlation with shoulder injury, divide research objects into two groups according to shoulder injure status, relative measurement data as Table 4 shows.

Make statistical analysis of injured group and uninjured groups at every posture angle in hitting process, checking results T as Table 5 shows.

Table 5： Checking results of injured and uninjured group's posture angle T in hitting

	T	$Sig(2-tailed)$
Horizontal stretching angle	-0.16	0.82
Rotation exterior angle	-0.24	0.73
Abduction angle	3.98*	0.02

**： Correlation is significant at the 0.05 level.*

The above checking results show that shoulder injured athletes and uninjured athletes have significant difference in upper arm's abduction angle at push moment, while no significant differences in horizontal stretching angle and rotation exterior angle.

Hitting process is a forward swing, internal rotation motion that upper arm made from lifting position, in which upper arm's horizontal stretch angle gradually reduced .The maximum angle in push moment is formed by athletes active lifting, commonly not go beyond normal range. The observation data indicates that upper arms average horizontal stretch angle of shoulder injured athletes in hitting moment is 72.21°,less than 74.10º that from uninjured athletes, all not arrive vertical lift position of 90º, therefore it cannot be regarded as the causes of shoulder injury. After hitting motion started, upper arm makes contra rotation against swing direction, get shoulder injured athletes maximum rotation exterior angle as 62.25º in hitting process, less than 66.43°that from uninjured athletes, all far away from the maximum angle that obtained in the moment human upper arm take free exercises, so that it also can not regarded as the key factor caused shoulder injury. Slightest difference in horizontal stretching angle and rotation exterior angle between injured and uninjured group can be thought that athletes movement ranges slightly reduced after their shoulder injured.

Statistical data shows that abduction angle is the main cause of shoulder injury. In spiking, upper arm external stretch direction nearly vertical to internal swing direction, which makes joint surrounding muscle bear great torque in push. Especially, continued strength after arm extending and holding process released at maximum speed, shoulder joint and muscle force are easily going beyond the normal range and cause injury. Shoulder injured athletes average abduction angle at push moment is 146.51°far beyond 117.23º that from uninjured, and relative research indicates the best range in this angle is 105°-130°that also got as average angle from uninjured group. It can be conclude that big abduction angle in shoulder at push moment is the main cause for athletes shoulder injury.

Elbow injury research: Upper arm motion trajectory in spiking process is a kind of whiplash motion, its force be transmitted from shoulder to elbow and wrist. In the process, elbow as the middle linking part, bear great accelerated speed in push and hitting process, therefore easily cause injury. According to spike motion features as well as arms anatomical characteristics, select typical kinematic parameters to do research, checking results of elbow main kinematic parameters as well as discrepancy between injured and uninjured group as below Table 6, Table 7 show.

Table 6：Key parameters comparison between elbow injured group and uninjured group in swing process

	maximum forearm rotation internal angle		maximum elbow stretch angle		maximum elbow accelerated speed	
	Injured group	Uninjured group	Injured group	Uninjured group	Injured group	Uninjured group
Minimum value	79.3	75.2	162.3	138.2	114.8	100.2
Maximum value	92.4	87.4	170.2	160.5	220.5	235.3
Average value	82.3	80.9	167.3	147.3	136.5	114.6
Standard Deviation	3.8	4.2	2.4	10.8	96.3	100.5

Table 7：Elbow injured and uninjured groups key parameters T checking results in swing process

Parameter	T	$Sig(2-tailed)$
Maximum forearm rotation internal angle	0.745	0.453
Maximum elbow stretch angle	6.351*	0.002
Maximum elbow ace. speed	0.982	0.328

**： Correlation is significant at the 0.05 level.*

Data in Table 6 shows that average value of injured and uninjured groups' forearm maximum rotation internal angle are respectively 82.3º and 80.9°,both of which not goes beyond forearm normal inside rotation range(below 145°),and T checking results in Table 7 also shows that inside rotation angle not significant correlated to elbow

injury. Besides, no significant discrepancies of maximum accelerated speed exist in two groups, so it also not the main cause to injury. But elbow injured group's athletes average elbow stretch angle reach 167.3°at push moment, some player maximum value even beyond 170°,while that from uninjured groups only reaches 147.3°。It can be seen from the above, injured groups athletes maximum elbow stretch angle is significantly larger than that of uninjured group, T checking results also show the significant correlations between the two groups.

Then make further research on relative technical factors that caused elbow excessive stretching by two maximum accelerated speeds segments at push moment and hit moment in hitting process .Considering possible correlation kinematic parameters as hitting height-to-height ratio, time difference between maximum arm stretch moment to hitting moment, time differences between maximum shoulder speed moment and hitting moment, get measurement parameters from injured group and uninjured group as below:

Table 8：Elbow injured and uninjured group parameter comparison

	hitting height-to-height ratio		time difference between maximum arm stretch moment to hitting moment		time differences between maximum shoulder speed moment and hitting moment	
	Injured group	Uninjured group	Injured group	Uninjured group	Injured group	Uninjured group
Minimum value	1.26	1.18	-0.68	-0.46	-0.02	0.01
Maximum value	1.48		0.46	0.38	0.21	0.33
Average value	1.36	1.31	0.08	-0.01	0.03	0.05
Standard Deviation	0.05	0.08	0.10	0.23	0.24	0.15

Analysis of maximum elbow abduction angle parameters correlation and significant influence to elbow injure as below Table 9, Table 10 shows.

Table 9： Analysis results of every parameters correlation to maximum elbow abduction angle

Parameter	Correlation Index	Significance
hitting height-to-height ratio	0.375*	0.035
time difference between maximum arm stretch moment to hitting moment	0.346*	0.039
time differences between maximum shoulder speed moment and hitting moment	0.384*	0.025

**：Correlation is significant at the 0.05 level.*

Table 10：Checking Result of every parameters with elbow injure T

Parameter	T	$Sig(2-tailed)$
hitting height-to-height ratio	1.745	0.153
time difference between maximum arm stretch moment to hitting moment	1.351	0.134
time differences between maximum shoulder speed moment and hitting moment	-2.543*	0.002

**：Correlation is significant at the 0.05 level.*

Analysis results in Table 9 shows that significant correlation existing among hitting height-to-height ratio, time difference between maximum arm stretch moment to hitting moment, time differences between maximum shoulder speed moment and hitting moment as well as maximum elbow abduction angle.

T checking results in Table 10 shows that only significant differences existing on maximum shoulder speed moment and hitting moment, which regarded as the factors has influence on elbow injured and uninjured athletes maximum elbow abduction factors through comparison .It proofs that key factors cause elbow injury is just time differences between maximum shoulder speed moment and hitting moment, while other two factors have less effects.

Volleyball spike motion belongs to upper whiplash motions, its features as firstly stretch arms and hold strength, concentrate whole body force to shoulder; after push, strength transmitting forward along upper arm successively to elbow, wrist; after push every joint trigs follow this order, in which momentum transfers to limbs end, till to volleyball at last, hitting process completed. While touch moment is the starting of trig process, which not only directly influence on final hitting efficiency but also every joint force and stretching. Table 8 data shows that average time differences between shoulder injured groups maximum speed moment and hitting moment just arrives at 0.03s, while 0.06s that from uninjured group. That indicates injured group athletes hit so earlier, their elbow joint hasn't arrived at the best stretch angle and continue to transfer momentum to arms end, elbows continue to stretch with balance momentum after hitting generated big stretch angle and then caused injury.

CONCLUSION

This paper utilizes analysis of college volleyball athletes spiking process, mainly get conclusion as below:

(1) Though main research objects in this paper is main attacker, common issues from college volleyball also can be found; Athletes that engaged in volleyball for more than 4 years, mostly suffer injury to different degree that majorly in the type of chronic strain and its injury part mainly concentrate on ankle, knees, waist, shoulder, elbow. Except for volleyball its own features caused injury, but mainly because of college athletes sports features. Unscientific kinematic motions, sports habits formed in long term as well as ignorance of slight injury that not treated and cared timely are the main cause for such chronic strain.

(2)Through kinematics and statistical analysis to 8 main attackers in spiking process, shoulders excessive outside stretching at push moment of spiking process is the main direct cause to shoulder injury. The remote cause is incorrect push sequence and excessive long time holding and stretching from upper arm. Methods to improve is that firstly correct push sequence, from lower limb drives and stretch to waist back turns then to shoulder hold ,make strength transfer from bottom to up, properly shorten hold time, reduce shoulder burden. Strengthen exercises like running , jumping and place kick spiking in training so as to form correct push sequence and enhance stability of spiking techniques; Meanwhile, waist and abdominal muscles strength flexibility together with upper and lower limbs training also should be strengthen to ensure that in spiking process arm stretch holding segments body can fully twist ,waist back share partial elastic potential energy rather than merely rely on upper arm excessive outside stretch to provide storing of elastic potential energy, then upper arms abduction angle triggered in hitting , shoulder burden reduced and avoid injury.

(3) In the stage of hitting in the air, excessive large elbow abduction angle is the main and direct cause to elbow injury. Among the multiple kinematic parameters that influenced maximum abduction angle in hitting moment, time difference between maximum shoulder speed moment and hitting moment is the main factors that effect on maximum abduction angle and led to sports injury. To solve this problem, combined with human anatomical features in volleyball spiking technical learning and training, correctly acknowledge motion principal, make clear of every joint push sequence, strengthen every segments trigger chances mastering, and strengthen upper limb strength exercise at the same time so that spiking efficiency can be ensured as well as accuracy of technical motions and prevent sports injury.

REFERENCES

[1] Li Yingfang. *Journal of Shandong sports institute*, **2003**, 4(19).
[2] Yun Dachuan, Hu Yong'xin. *Sports scientific literature bulletin*, **2007**, (01).
[3] Liu Hui. Biomechanics research of upper limb whiplash motion technical principal. *Sports Science*, **2004**.
[4] Zhang Qinghua. *Sports scientific research*, **2008**, 4(2).
[5] Zhang B.. *Int. J. Appl. Math. Stat.*, **2013**, 44(14), 422-430.