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Biomechanical Analysis of Dr. Mike Marshall's Pitching Technique

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Methods

Four pitchers taught by Dr. Mike Marshall were tested in the James R. Andrews Biomechanics Lab at the American Sports Medicine Institute. After warming up as wanted, each pitcher was tested pitching at full effort. Kinematic and kinetic data were then computed, using equations previously published by ASMI (see references).

A biomechanical evaluation is attached for each of the four subjects. In each report, the pitcher's data for the maxline fastball, torque fastball, dropout, screwball and/or curve are compared to traditional fastball mechanics thrown by healthy, elite pitchers previously tested at ASMI.

The hypothesis proposed was that pitching a Marshall-style fastball can produce comparable ball velocity as a traditional fastball, but with less risk of injury to the shoulder and elbow. To test this hypothesis, the torque fastball data for XXXXXXxxx, YYYYyyyyyyyyyy, and ZZZZzzzzzz were grouped together and compared to traditional pitching data. WWWWwwwwww was not included, as he had less ball velocity than the other three subjects, and his kinematics did not match well the data of the other three. The torque fastball was used, as it was the fastest pitch thrown by the Marshall-style pitchers. The "torque group" was compared to two groups of subjects previously tested at ASMI – an elite group, and a matched group. The elite group was comprised of healthy professional and collegiate pitchers who threw at least 85 mph during testing. The matched group was made up of healthy pitchers with similar height, weight, and fastball velocity as the torque group.

Results

Kinematic and kinetic data for the torque group and elite group are compared in Table 1 below. "Low" indicates the mean minus one standard deviation (Mean-SD) for the elite pitchers, and "High" indicates the mean plus one standard deviation (Mean+SD) for the elite pitchers. A red "X" indicates that the mean value for the torque group was either below the Low or above the High value for the elite range. For reference, the "A, B, C,…" indicate where a parameter appears on the individual evaluations.

The torque group produced significantly less ball velocity than the elite group. The height and weight of the torque group were within the elite group range. As expected, there were numerous kinematic differences between the torque and elite groups. This included significantly less knee lift and shorter stride for the torque group. The front foot landed "closed" (to the thirdbase side, for a righty) for traditional pitching, but open for the torque group. The torque group generated significantly less (and later) trunk rotational velocity, which seems consistent with the teaching of the style. The torque group also generated significantly less external rotation of the throwing shoulder. At the instant of ball release, the torque group had significantly less forward trunk tilt and more sideways trunk tilt than traditional pitchers. Shoulder abduction was in the elite range. This shoulder abduction, coupled with greater sideways trunk tilt (towards the glove side), created a more "over-the-top" release point for the torque fastball, compared to the elite pitchers. Kinetic values for the torque group were within the normal ranges for the elite traditional pitchers.

Table 1. Comparison between Marshall pitchers and elite traditional pitchers

VARIABLE		TORQUE GROUP MEAN VALUE			ELITE GROUP LOW		ELITE GROUP HIGH	
Velocity		**77**	**MPH**	X	**85**	**to**	**89**	
Height		**75**	**Inches**		**73**	**to**	**77**	
Weight		**221**	**Pounds**		**185**	**to**	**233**	
Humerus length		**38**	**Cm**		**37**	**to**	**41**	
Radius length		**30**	**Cm**		**28**	**to**	**31**	
MAXIMUM KNEE HEIGHT								
Maximum Knee Height		**24**	**% height**	X	**60**	**to**	**68**	
Pelvic Drift	**A**	**11**	**Inches**		**6**	**to**	**9**	X
Head Roll		**-2**	**Degrees**	X	**11**	**to**	**34**	
Head Pitch		**-13**	**Degrees**	X	**-11**	**to**	**8**	
Head Yaw		**-22**	**Degrees**		**-49**	**to**	**-29**	X

FOOT CONTACT

Stride Length Ratio	B	62	% height	X	77	to	87	
Lead Foot Position	D	-3	Inches	X	5	to	13	
Lead Foot Angle	E	9	Degrees		7	to	26	
Knee Flexion	C	43	Degrees		36	to	52	
Pelvis Rotation	F	12	Degrees	X	20	to	41	
Trunk Separation	G	-36	Degrees		-59	to	-38	X
Side Trunk Tilt	H	-9	Degrees	X	-4	to	12	
Throwing Shoulder Abduction	I	107	degrees		78	to	103	X
Throwing Shoulder Horizontal Abduction	L	-2	degrees	X	13	to	34	
Throwing Shoulder External Rotation	K	52	degrees		24	to	79	
Throwing Elbow Flexion	J	62	degrees	X	74	to	107	

ARM COCKING

Maximum Pelvis Rotation Velocity	M	567	degrees / sec		522	to	675	
%tMPRV	N	56	% time		17	to	41	X
Maximum Lateral Trunk Flexion Velocity		323	degrees / sec		249	to	374	
%tMLTFV		59	% time		19	to	48	X
Maximum Upper Trunk Rotation Velocity	O	958	degrees / sec	X	1075	to	1223	
%tMUTRV	P	75	% time		39	to	58	X
Maximum Trunk Separation Velocity		368	degrees / sec	X	427	to	648	
%tMTSV		95	% time		36	to	74	X
Maximum Throwing Shoulder External Rotation Angular Velocity		405	degrees / sec	X	1291	to	1866	

MAXIMUM EXTERNAL ROTATION

Maximum Throwing Shoulder External Rotation	Q	162	degrees	X	173	to	191	
Maximum Throwing Shoulder Horizontal Adduction	R	15	degrees		9	to	22	
Throwing Elbow Flexion	S	116	degrees		88	to	116	X
%tEA		69	% time		42	to	69	X

ARM ACCELERATION

Maximum Pelvis Deceleration	W	16	m / s^2	X	22	to	38	
%tMPD	X	59	% time		30	to	72	
Maximum Throwing Shoulder Internal Rotation Angular Velocity	T	7899	degrees / sec		6558	to	8536	
Maximum Throwing Elbow Extension Angular Velocity	U	2509	degrees / sec		2146	to	2680	
%tMEEAV	V	94	% time		89	to	94	

BALL RELEASE

Lead Shank Angle	AB	9	degrees		8	to	22	
Lead Knee Flexion	Z	21	degrees		20	to	46	
Lead Hip Flexion	Y	119	degrees		89	to	109	X
Forward Trunk Tilt	AC	22	degrees	X	29	to	42	
Side Trunk Tilt	AD	42	degrees		14	to	31	X

(Average) Throwing Shoulder Abduction	AE	93	degrees		87	to	103
Throwing Elbow Flexion	AF	20	degrees		19	to	28
MAXIMUM INTERNAL ROTATION							
Lead Knee Flexion	AH	5	degrees	X	11	to	36
Forward Trunk Tilt	AG	28	degrees	X	40	to	57
Maximum Throwing Elbow Flexion		18	degrees		16	to	24
FORCES							
Maximum Throwing Shoulder Anterior Force		364	Newtons		267	to	403
Maximum Throwing Shoulder Proximal Force		1264	Newtons		1094	to	1436
Maximum Throwing Elbow Proximal Force		1150	Newtons		1029	to	1319
TORQUES							
Maximum Throwing Shoulder Horizontal Adduction Torque		128	Newton-meters		87	to	135
Maximum Throwing Shoulder Internal Rotation Torque		106	Newton-meters		80	to	116
Maximum Throwing Elbow Varus Torque		108	Newton-meters		80	to	113
Maximum Throwing Elbow Flexion Torque		49	Newton-meters		38	to	64

Kinematic and kinetic data for the Marshall pitchers are compared to a matched-group of traditional pitchers in Table 2 below. In this table, “High” and “Low” represent the mean +/- one standard deviation for the matched-group. The height, weight, and ball velocity of the torque group were within the matched-group range. There were numerous kinematic differences between the torque group and matched-group. In general, these were the same kinematic differences as seen between the torque and elite groups. Kinetic values for the torque group were above the normal ranges for the matched-group.

Table 2. Comparison between Marshall pitchers and a matched-group of traditional pitchers

VARIABLE	TORQUE GROUP			MATCHED GROUP		
	MEAN VALUE			LOW		HIGH
Velocity	75	MPH		74	to	77
ANTHROPOMETRICS						

Height		75	inches		75	to	77	
Weight		221	pounds		171	to	222	
Humerus length		38	cm		36	to	39	
Radius length		30	cm		28	to	30	X

KINEMATICS

MAXIMUM KNEE HEIGHT

Maximum Knee Height		24	% height		n/a	to	n/a	
Pelvic Drift	A	11	inches		n/a	to	n/a	
Head Roll		-2	degrees		n/a	to	n/a	
Head Pitch		-13	degrees		n/a	to	n/a	
Head Yaw		-22	degrees		n/a	to	n/a	

FOOT CONTACT

Stride Length Ratio	B	62	% height	X	73	to	82	
Lead Foot Position	D	-3	inches	X	8	to	11	
Lead Foot Angle	E	9	degrees	X	10	to	29	
Knee Flexion	C	43	degrees		39	to	52	
Pelvis Rotation	F	12	degrees		7	to	30	
Trunk Separation	G	-36	degrees		-55	to	-32	
Side Trunk Tilt	H	-9	degrees	X	-2	to	16	
Throwing Shoulder Abduction	I	107	degrees		73	to	95	X
Throwing Shoulder Horizontal Abduction	L	-2	degrees	X	10	to	34	
Throwing Shoulder External Rotation	K	52	degrees		-4	to	58	
Throwing Elbow Flexion	J	62	degrees	X	64	to	110	

ARM COCKING

Maximum Pelvis Rotation Velocity	M	567	degrees / sec		492	to	572	
%tMPRV	N	56	% time		20	to	50	X
Maximum Lateral Trunk Flexion Velocity		323	degrees / sec		226	to	338	
%tMLTFV		59	% time		20	to	70	
Maximum Upper Trunk Rotation Velocity	O	958	degrees / sec	X	1003	to	1113	
%tMUTRV	P	75	% time		40	to	63	X
Maximum Trunk Separation Velocity		368	degrees / sec	X	395	to	597	
%tMTSV		95	% time		47	to	78	X
Maximum Throwing Shoulder External Rotation Angular Velocity		405	degrees / sec	X	1208	to	1852	

MAXIMUM EXTERNAL ROTATION

Maximum Throwing Shoulder External Rotation	Q	162	degrees		162	to	176	
Maximum Throwing Shoulder Horizontal Adduction	R	15	degrees		10	to	29	
Throwing Elbow Flexion	S	116	degrees		80	to	115	X
%tEA		69	% time		38	to	72	

ARM ACCELERATION									
Maximum Pelvis Deceleration	**W**	**16**	**m / s^2**	X	**18**	**to**	**30**	
%tMPD	**X**	**59**	**% time**		**27**	**to**	**62**	
Maximum Throwing Shoulder Internal Rotation Angular Velocity	**T**	**7899**	**degrees / sec**		**5354**	**to**	**6393**	X
Maximum Throwing Elbow Extension Angular Velocity	**U**	**2509**	**degrees / sec**		**1722**	**to**	**2235**	X
%tMEEAV	**V**	**94**	**% time**		**93**	**to**	**95**	
BALL RELEASE								
Lead Shank Angle	**AB**	**9**	**degrees**		**0**	**to**	**12**	
Lead Knee Flexion	**Z**	**21**	**degrees**	X	**27**	**to**	**61**	
Lead Hip Flexion	**Y**	**119**	**degrees**		**88**	**to**	**126**	
Forward Trunk Tilt	**AC**	**22**	**degrees**		**21**	**to**	**37**	
Side Trunk Tilt	**AD**	**42**	**degrees**		**16**	**to**	**28**	X
(Average) Throwing Shoulder Abduction	**AE**	**93**	**degrees**		**87**	**to**	**106**	
Throwing Elbow Flexion	**AF**	**20**	**degrees**	X	**26**	**to**	**32**	
MAXIMUM INTERNAL ROTATION								
Lead Knee Flexion	**AH**	**5**	**degrees**	X	**21**	**to**	**51**	
Forward Trunk Tilt	**AG**	**28**	**degrees**	X	**31**	**to**	**53**	
Maximum Throwing Elbow Flexion		**18**	**degrees**	X	**21**	**to**	**27**	

KINETICS

FORCES								
Maximum Throwing Shoulder Anterior Force		**364**	**Newtons**	**194**	**to**	**314**	X
Maximum Throwing Shoulder Proximal Force		**1264**	**Newtons**	**842**	**to**	**1043**	X
Maximum Throwing Elbow Proximal Force		**1150**	**Newtons**	**725**	**to**	**980**	X
TORQUES							
Maximum Throwing Shoulder Horizontal Adduction Torque		**128**	**Newton-meters**	**61**	**to**	**99**	X
Maximum Throwing Shoulder Internal Rotation Torque		**106**	**Newton-meters**	**53**	**to**	**82**	X
Maximum Throwing Elbow Varus Torque		**108**	**Newton-meters**	**52**	**to**	**81**	X
Maximum Throwing Elbow Flexion Torque		**49**	**Newton-meters**	**29**	**to**	**49**	X

Discussion

The data did not support the hypothesis that the Marshall style of pitching produces less risk of injury but with comparable ball velocity as traditional pitching. While the current study provides no direct measurement of injury risk, the biomechanical data do provide shoulder and elbow kinetic parameters.

Cadaveric and mathematical modeling have linked total joint force and torque to loads on individual tissues, like rotator cuff tendons and ulnar collateral ligament (see references). Thus, elbow varus torque coupled with elbow flexion has been correlated with tension in the UCL. Shoulder internal rotation torque coupled with shoulder external rotation angle has been correlated with SLAP tears and internal impingement of the infraspinatus in the shoulder capsule. Shoulder proximal force has been linked to rotator cuff tensile tears and SLAP tears.

Compared to elite traditional pitchers, the torque fastball pitchers produced similar shoulder and elbow torques, but significantly less ball velocity. Compared to a matched traditional group, the torque fastball group produced similar ball velocity, but required significantly greater shoulder and elbow force and torque.

Accuracy was also an issue. Collectively, the three skilled Marshall-style pitchers threw only one-third (9 out of 27) of their maxline fastballs for strikes, and about one-fourth (5 out of 21) of their torque fastballs for strikes.

While the current study does provide some insight into the performance and safety about various styles of pitching, future research would also be helpful. Biomechanical testing of a larger sample of Marshall-style pitchers would be valuable, as would long-term outcomes of performance and injury compared between Marshall-style and traditional pitchers.

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