COMPARISON OF PUTTING KINEMATICS WHEN USING A TRADITIONAL BLADE PUTTER AND A PUTTER PROTOTYPE

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INTRODUCTION

This study examined the effectiveness of a golf putter prototype and a traditional blade putter on the joint action necessary to complete a medium distance putt. A kinematic analysis of the upper body joints and torso actions was performed to determine if the putting technique utilized with the experimental style putter could reduce the joint action variability needed for the execution of a putt.

METHODS

Video records were taken from a frontal and a 45 degree side view of 6 experienced golfers performing putts with a conventional and an experimental putter. The experimental putter was designed such that the putter's blade was positioned in front and perpendicular to the shaft of the putter. This blade redesign resulted in the golfers supporting the golf club shaft along the anterior surface of their arm while crouched and facing the cup. This repositioning permitted the sighting of the cup with a frontal view rather than the traditional tilted side view (see Figure 1).

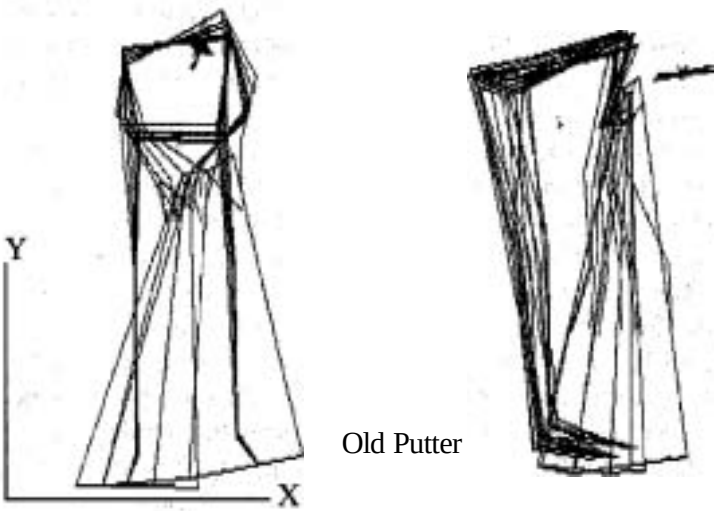


Figure 1. Traditional and New Putting Techniques

The subjects were permitted practice trials until they felt comfortable using each putter. Three putts with each putter from the same distance and position from the cup were performed outdoors at a golf club in California and videotaped at the rate of 60 fps . A 3-D reference cube using 11 fiducial points was placed in the field of view of both cameras simultaneously in order to convert the video images to real life scale. The third trial using each putter was selected for kinematic analysis and the camera view from each videotape was digitized using an Ariel APAS.

The 23 coordinates digitized included the following data points: the left foot, left ankle, left knee, left hip, right hip, right knee, right ankle, right foot, left hand, left wrist, left elbow, left shoulder, right shoulder, right elbow, right wrist, right hand, top of grip, club head, top of head, chin, right eye, left eye, and ball. The 2 camera views were synchronized by identifying the ball contact frame. Then the 2 synchronized camera views were transformed into real scale coordinates and the data point endpoint coordinate positions were smoothed using a quintic spline function with a error value of 2. .

DATA REDUCTION

The computer simulated motion of each putt for the two styles of putter used by the 6 golfers (12 total trials) were viewed to determine the frame that the end of backswing and ball contact occurred. The intersegmental joint angle for the shoulder, elbow, and wrist joints at the frame for the end of the backswing and ball contact were determined along the xy plane about the z axis and along the zy plane about the x axis. The xy plane of motion (z axis) identified the amount of flexion/extension occurring at these joints while the zy plane of motion (x axis) determined the amount of abduction/ adduction occurring.

The angular displacement (difference) between the backswing and contact positions represented the range of motion (ROM) occurring at the joints during the putting movement about the z and x axes. The sum of the shoulder, elbow, and wrist ROMs in the particular planes were identified as the upper body ROM about either the x or z axis. The change in the shoulder orientation taken from an overhead view for the backswing and contact frames represented the spinal rotation experienced by the torso during putting.

The total of the joints of the upper body ROMs summed in the zy plane and the shoulder rotation represented the body movement that would produce lateral movement (right/left) from the desired putting line. The sum of the upper body ROMs along the xy plane (z axis) produced by flexion / extension

of those joints would produce the forward/backward motion of the club head needed to strike the ball and push it towards the hole.

A ratio the ROMs found for the new putter and the old traditional putter was determined to show the percentage of reduction in the joint's ROM that resulted from the new putter design. A ratio less than 1 or 100% would indicate that the prototype putter reduced the amount of motion necessary to complete the putt, thus making it more efficient and more likely to have less human error introduced while putting. The length of the putting stroke was measured from the backswing position to ball contact.

The golfer's viewing angle represented the orientation of the eye plane in respect to the horizontal in the direction of the hole. If the eye plane was found to be 90 degrees then the head would be tilted sideways in respect to the horizontal. An 90 degree viewing orientation would result in the stereoscopic perspective being more sensitive to vertical deviations while an 0 degree or horizontal positioning would detect lateral putting errors:

Additionally, the golfers head position better facilitated a look at the hole putting technique which was found by Lissner (1985) to be more effective than looking at the ball putting technique.

RESULTS

The following findings were determined for the kinematics of the putting techniques utilized when putting with a traditional and experimental putter prototype.

Four males and 2 females served as putting subjects for this study. The males mean weight was 73.0 + 2.9 lbs and mean height was 173.0 + 19.1 inches, while the female golfers' mean weight was 67.5 + 2.1 lbs and their mean height was 131.5 + 33.2 inches.

Intersegmental joint angles were determined for the shoulder, elbow, and wrist at the end of the back swing at contact. The joint angle difference between these two positions represented the joint ROM along the xy plane (z axis) or zy plane (x axis).

Motion along XY Plane (Z axis)

The traditional putting technique exhibited 15.4 degrees of flexion at the shoulder joint, 6.8 and 7.95 degrees of movement at the elbow and wrist joints, respectively. The summed ROMs resulted in 30.1 degrees of motion (flexion/extension) of the upper body (See Table 1 & Figure 2). The new putter design afforded 9.9, 3.5, and 4.4 degrees of motion (flexion/extension) along the xy plane at the shoulder, elbow, and wrist joint,

respectively. Statistical analysis using a related t test found the wrist and total upper body motion to be statistically different at the .10 level of significance. The new putter design utilized 59% of the putting xy ROM required by a traditional putting technique. This smaller ROM required to complete the forward / backward movement would indicate that the new putter design produced a more efficient putting stroke to push the ball while reducing the joint ROM variability and likelihood for error. The length of the backswing necessary to complete the same putt was 43.3 and 28.6 cm for the old and new putters.

Motion along ZY Plane (X axis)

The traditional putting technique utilized 4.7, 13.4, and 17.8 degrees of motion along the zy plane for the shoulder, elbow, and wrist joints. In contrast, the experimental putter required 3.3, 1.3, and 8.9 degrees of motion at the shoulder, elbow and wrist (See Figure 3).

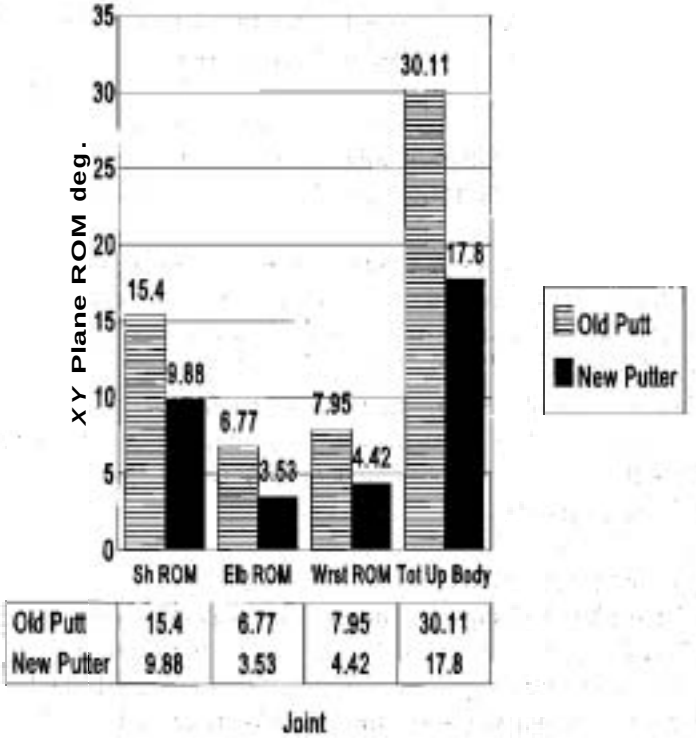
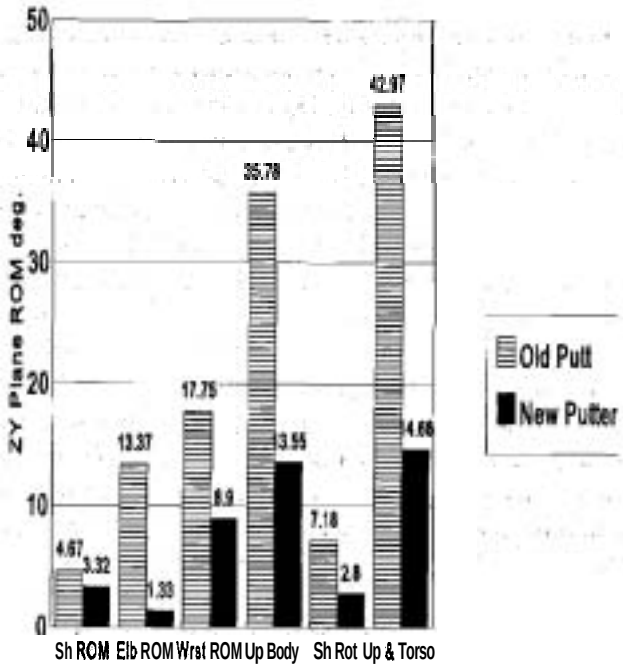


Figure 2. XY plane ROM during Flexion/Extension (deg).



Old Putt	4.61	13.37	17.15	35.78	1.18	42.97
New Putter	3.32	1.33	8.9	13.55	2.8	14.68

Figure 3. ZY plane ROM during Putting abduction/adduction (deg).

Table 1. Combined mean joint ranges of motion during putting.

Variable	Old Putt M±SD	%New/Old	New Putter M±SD	Dif±SD M±SD	T Prob
Up Body XY ROM deg	30.1±12.7	59.1%	17.8±5.37	12.3±15.4	.10*
Up Body ZY ROM deg	35.8±16.4	38.0%	13.6±17.8	22.2±19.0	.035**
Torso ROM deg	7.2±4.1	38.9%	2.8±4.1	4.4±3.7	.033**
Total ROM deg	73.1±12.1	44.5%	32.5±19.0	40.6±21.7	.006**

NOTE: * Indicates significance at .10 level
** Indicates significance at .05 level

Statistical analysis found only the elbow to demonstrate a significantly different joint action (p=.017) when comparing the two putting techniques. The putting technique using the experimental putter required only 9.9% of the elbow ROM that was used by the traditional putter. This reduction in motion was due to the elbow being placed extended behind the club shaft hanging alongside the trunk in the new putting technique and during the traditional technique the elbows are partially flexed or extended while forming a putting triangle between the shoulders, upper arms, and forearms. The triangle is pitched away from the torso in order to provide the necessary swing clearance. Since the new putting technique requires about 1 degree of motion at the elbow joint to putt while the traditional movement requires 13.4 degrees, there is a significant reduction in the potential variability or error.

The upper body combined motion in the zy plane (x axis) represented by the sum of the shoulder, elbow, and wrist joint ROMs were 35.8 degrees for the traditional and 13.6 degrees for the new putting technique. Again, a significant (p=.035) reduction in the upper body motion occurred while using the experimental putter to accomplish the same putt. The new putting technique required only about 38% of the joint zy ROM employed with a traditional putting style (see Figure 4).

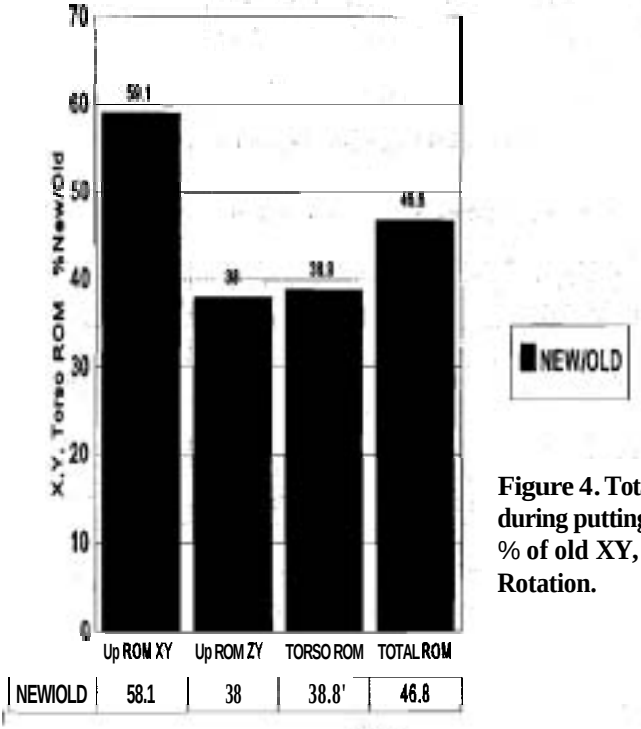


Figure 4. Total joint ROMs during putting expressed as % of old XY, ZY, & Torso Rotation.

Torso/Shoulder Rotation about Vertical Axis

The amount of rotation of the shoulder/torso was calculated from an overhead perspective. The torso rotation about this axis was 7.2 degrees and 2.8 degrees for the traditional and experimental putting techniques (See Table 1 & Figures 3). The new putting technique stabilized the shoulder girdle and the shoulder joint provided the impetus of propulsion while the traditional putting style used significantly greater ($p=.033$) trunk rotation to putt the golf ball. The new putter required only 39% of the trunk rotation needed by the traditional putter.

Total Body Range of Motion

The total body ROM represented the sum of the upper extremities' ROMs about the z and x axes and the torso rotation. No lower body joint actions were calculated because during a pilot study only about 1 degree of ROM occurred at each joint while putting, thus the lower body contribution was considered negligible. The traditional putting technique utilized 73.1 degrees of combined motion while the experimental putter required 34.2 degrees of motion (See Table 1). This new putter needed only 46% of the joint motion required by the traditional putting technique (See Figure 3) and the differences were statistically significant at the .006 level .

CONCLUSIONS

The new style putter significantly reduced the upper body ROM, shoulder rotation, and total body motion needed to execute a successful putt when compared to the traditional putter. This reduction of putting movement needed to use the experimental putter would indicate that it uses more efficient putting mechanics while reducing the potential for variability / error in the lateral direction of the putt, which is similar to the side saddle putting technique employed by Snead (1982). Therefore, the new putter may be viewed superior in its kinematic efficiency.

REFERENCES

Lissner, M. (1985). A comparison of accuracy between two putting techniques. Unpublished master's thesis, Indiana State University, Terre Haute, Indiana.

Snead, S. (1982). My sidesaddle style can work for you, too. Golf Digest, 33 (9), 60.