Temporary Correction of Transverse Plane Pelvic Rotation Via a Three Minute Exercise Program

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ABSTRACT

A sample of 25 golfers, 12 professionals and 13 amateurs, ages 23 to 63 years, were measured for transverse plane pelvic rotation using light electrodes positioned bilaterally on the iliac crests. Transverse plane pelvic rotation was present in all of the golfers measured. All subjects were measured from a shoulder width stance, two inches wider and two inches narrower than shoulder width in a standing, erect posture and a golf set-up posture without a club. Transverse plane pelvic rotation in the 25 subjects ranged from 1 inch to 4 inches as recorded by stance correction with an average of 2.25 inches of rotation at a shoulder width stance. A dowel pole bar with light electrodes fixed to the bar was attached to the transverse pelvic plane 3 inches below the iliac crest for the purpose of validation of a measurement instrument in the field. The pelvic rotation was temporarily corrected through a simple three minute exercise program.

Nineteen of the 25 subjects were seen in follow-up in the field where the dowel bar was used and they had each returned to their measured baseline pelvic rotation. Again, their measured pelvic rotation was corrected via a simple three minute exercise program. The authors discuss the use of the exercise program for both golf coaching and research, and also present the validation of a simple instrument that could be used in the field to measure transverse pelvic plane rotation.

Key words: Golf, Hip Alignment, Posture, Stance, Trunk Stabilization

Reviewers: Dan Goldstein (Dynamic Balance System, USA)
David Lindsay (University of Calgary, Canada)
Michael Voight (Belmont University, USA)
INTRODUCTION
A gold standard in golf instruction is to teach a stance that is parallel to the intended line of ball flight or roll (target line), the hips (transverse plane of the pelvis) and the shoulders. This teaching method is well documented in golf-instructional texts [1-6]. There appear to be as many instruction books that either do not address alignment [7, 8] or players who describe their address position at the ball as other than parallel to their target line [9-11].

The Professional Golfers’ Association (PGA) of America Teaching Manual [12] describes square stance, square hips, square shoulders as a good starting position. It suggests that adjustments are likely necessary from this parallel lines set-up position depending on variations in the player’s body.

Instructors frequently place a club on a player’s heel line to check their stance alignment relative to their target line [5, 13]. The assumption of checking alignment on a golfer’s stance line is that if their feet are parallel to their target line, their hips (transverse frontal plane of the pelvis) will be parallel as well. Individual anatomic variations observed in this study suggest the assumption that a stance line that is parallel to the target line equals a parallel pelvic line is more likely the exception than the norm.

The researchers used externally placed light electrode body markers attached to the iliac crests, among other locations (Figure 1) to measure transverse plane rotation of the pelvis.

The primary purpose of this study was to investigate whether golfers maintain parallel stance and pelvic rotation alignment in a standing erect posture and a golf address position without a club. The secondary purposes of this study were to:

• Assess the effect of changes in stance width on pelvic rotation
• Determine the effect of a 3 minute exercise program on pelvic rotation
• Validate a pelvic rotation measurement tool to be used in the field
• Determine the long-term effectiveness of the pelvic rotation correction exercises

METHOD
SUBJECTS
The subjects in this study were 25 participants in a research project in Dr. Frank Jobe’s Biomechanics Lab at Centinela Hospital, Los Angeles, California, USA. The 25 subjects participating in the biomechanics lab study were all males ranging from 23 to 63 years of age. Thirteen of the subjects were golf professionals with a playing index of + 2 or better. Twelve of the subjects were amateurs with a playing index of 2 to 14.

The research protocol used in the Centinela Hospital Biomechanics Lab was approved by the Hospital Institutional Review Board and all subjects signed an informed consent to participate in the study.

MEASUREMENT
The 25 subjects participating in the biomechanics lab study were part of a comprehensive research protocol on balance. A pilot study with five subjects preceded the primary research phase. The protocol and measurement tools were
tested for validity during the pilot phase. Each subject had 40 light electrodes attached to their body at precise anatomical landmarks by a biomedical technician, including the iliac crests, the landmarks of measurement for this study. A study by Lucas et al. [14] showed that, within limits, the transverse plane rotation of the pelvis can be determined by a left/right ratio of the distances between two similar landmarks on each side of the pelvis as, for example, the iliac crests.

Figure 1. Body Marker Attachment to Iliac Crests
Wooden dowel poles measuring 1 inch in diameter by 4 feet long with light electrodes attached to the pole were placed on the transverse frontal plane of the pelvis 3 inches below the iliac crests and parallel to the floor. The dowel pole was attached using a bungee cord with 1-inch plastic hooks. The elastic cord was stretched across the subject’s mid-buttocks and the dowel pole was adjusted parallel to the ground. The elastic bungee cord was set unobstructed by, for example, the subject’s belt, contents of his pockets and the hooks on the bungee cord were faced downward on the dowel pole (Figure 2). The purpose of the use of the wooden dowel was to validate its use in the field.
Light electrodes were placed on the floor to establish a reference from which to measure transverse plane pelvic rotation. The protocol directed the subjects to assume a stance on a lined vinyl mat in a standing tall, erect posture. The vinyl mat was set parallel to the light electrode marked target line using a laser light level. All subjects’ measurements were taken relative to that target line with the heels and toes of both feet 90 degrees to that line (Figure 3).

The subject’s stance corrections of the noted transverse plane pelvic rotation were set at 1-inch intervals by moving either the left or right foot straight back on the lined vinyl mat and perpendicular to the floor target line. The horizontal lines on the vinyl set up mat were spaced one inch apart.

The subject’s transverse plane pelvic rotation was observed in both a standing tall, erect posture and a golf set up posture without a club at shoulder width, 2 inches narrower and 2 inches wider than shoulder width stance (Figures 4 and 5).

In both the biomechanics lab and in a follow-up with 19 of the subjects, the subjects were instructed to stand on a lined vinyl mat with both feet (heels and toes) perpendicular to the same reference line (Figure 6) then the dowel pole was attached.

The subjects were instructed to stand erect without knee flexion, with their arms hanging inside the bar and at their sides. Then they were instructed to take a deep breath, exhale and relax their body with particular focus on their hips and shoulders.
The direction of the transverse plane pelvic rotation (left or right) was recorded. The subject was instructed to adjust the position of either their right or left foot by placing that foot 1 inch behind the line that foot was on. The pelvic rotation correction was accomplished by changing the position of the same foot as the noted direction of the rotation. For example, if the transverse plane pelvic rotation was left, the left foot was adjusted by pulling that foot back 1 inch at a time.
The researcher stood next to the subject and viewed the orientation of the dowel pole relative to the lines on the vinyl mat. When the dowel pole and the vinyl mat lines were visually perceived by the researcher as parallel, the subject’s frontal transverse pelvic plane was deemed to be parallel to the target line.

With each adjustment the subject was asked to relax. Adjustments of 1 inch at a time continued until the dowel pole was parallel to the lines on the mat (Figures 7 and 8). Upon setting the dowel pole parallel to the lines on the mat with stance adjustments, the amount of correction in inches necessary to set the dowel pole
parallel to the lines on the vinyl mat was recorded. Then the subjects were asked to adjust their stance width first by two inches wider (Figure 9) and then two inches narrower (Figure 10). The amount of pelvic rotation and direction with each stance width change was recorded. Again, the subject’s stance was adjusted by moving either the left or right foot backward 1 inch at a time until the dowel pole was visually deemed to be parallel to the lines on the mat.

Figure 7. Getting Frontal Pelvic Plane Parallel with Ball-Target Line by Adjusting Left Foot

Figure 8. Getting Frontal Pelvic Plane Parallel with Ball-Target Line by Adjusting the Right Foot

Figure 9. Stance Widened by Two Inches
TREATMENT

All subjects were instructed in a three-minute modification of an exercise ("Dead Bug") taken from Dr. Robert Watkins’ Trunk Stabilization program [15]. The subjects were taught the exercise through verbal instruction and a demonstration of each exercise. As the researcher reclined in the exercise position, he narrated the exercise procedure. All four exercises were demonstrated simultaneously with narration. If the subjects were not doing the exercises correctly, the researcher verbally and physically corrected the exercise motion. The first exercise is shown in Figure 11.

Figure 10. Stance Narrowed by Two Inches

Figure 11. Exercise 1
In the lab, the exercise was done on a padded mat on the concrete floor. In the field during the follow-up phase, the subjects reclined on the vinyl mat used to do the measurement. The vinyl mat was placed on the ground. The verbal instructions during the demonstration of the first exercise were as follows:

“Lay flat on your back with your head touching the floor (ground). Bend your knees so that your feet are flat on the floor (ground) and as close to your buttocks as possible. When you flatten your back, your lower buttocks moves up as your upper pelvis (hips) rotates toward the ground. You should feel your back flat on the floor (ground). The closer your feet are to your buttocks, the easier it is to set your back flat. You will feel a tightening of your abdominal muscles as you flatten your back. Take a deep breath before you begin the exercise motion. As you exhale, extend your right arm over your head and behind you until you touch the floor (ground) with your hand. Hold your flat-back position during the entire exercise. Inhale and return your arm to its original position at your side. Repeat this motion with your left arm. Continue this alternating arm exercise until you do a total of 20 repetitions, ten repetitions with each arm.”

The verbal instructions during the demonstration of the second exercise were as follows:

“In the same starting position, repeat this exercise with your legs (Figure 12) with your arms resting at your side. Hold your flat-back position during the entire exercise. Take a deep breath. As you exhale, extend your right leg fully until it is 1 inch off the floor (ground.) As you inhale, return your right leg to its starting position. Take another deep breath and extend your left leg until it is one inch off the ground. Inhale as you return your left leg to the starting position. Repeat this exercise, alternating your left and right legs until you have done ten repetitions with each leg for a total count of twenty. Be certain your back is flat on the floor through every repetition. Start each repetition with a deep breath. Exhale as you extend your leg fully until your foot is 1 inch off the ground. Return that leg to the starting position as you inhale. Your back must be held flat on the floor (ground) during the entire exercise.”

The verbal instructions during the demonstration of the third exercise were as follows:

“Next, from the same starting position as the first two exercises take a deep breath and exhale as you extend your right arm and left leg. Again, be certain to hold your back flat as you extend your right arm and left leg. Your left leg should be extended until your foot is 1 inch off the ground and your right arm should be extended until your hand touches the floor (ground.) Inhale as you return your right arm and left leg to their starting positions (Figure 13). Repeat this motion with your left arm and right leg. Hold your flat back position during each repetition. Start each repetition with a
Figure 12. Exercise 2

Figure 13. Exercise 3
deep breath before you begin the exercise motion. Extend your opposite arm and leg as you exhale and return to your starting position with your inhalation. Continue this alternating arm and leg exercise until you do a total of 20 repetitions, ten repetitions with each arm and leg.

“Lastly, stretch your back by placing your buttocks on your heels and your arms and hands extended in front with your head down. Crawl out slowly with your finger tips as you lower your head further. You should feel a gentle stretch in your back. Once you feel a gentle stretch of your low back hold that position for twenty seconds” (Figure 14) (This exercise was done once.)

Upon completion of the exercises, all subjects were re-measured using the mat, dowel pole and bungee cord in the same manner as the baseline measurements were taken. In the lab, the light electrodes positioned on the iliac crests were used in addition to the dowel poles.

Nineteen of the 25 subjects attended a follow-up phase where the dowel pole and vinyl mat were used to assess pelvic rotation.

RESULTS
The 25 golfers sampled had a left or right rotation of their frontal pelvic plane (Figures 15 and 16) The stance correction of this rotation required that the player change their stance line (Figures 17 and 18) to set their pelvic line parallel to their target line in a standing tall, erect posture.
Figure 15. Left Rotation of Frontal Pelvic Plane

Figure 16. Right Rotation of Frontal Pelvic Plane

Figure 17. Stance Correction for Left Rotation of Frontal Pelvic Plane

Figure 18. Stance Correction for Right Rotation of Frontal Pelvic Plane
When a player changed the width of their stance to wider (Figure 19) or narrower (Figure 20) their frontal pelvic plane rotated more or less than the observed shoulder width stance rotation that was recorded. Thus, each change in stance width required a change in right or left foot placement to accommodate this rotation. When the subjects assumed a golf set-up position without a golf club, the orientation of the transverse pelvic plane was the same as that observed in the standing tall, erect posture in all stance widths.

![Figure 19. Frontal Pelvic Plane Rotated More Than the Observed Shoulder-Width Stance When Stance Widened](image1)

The range of measured transverse plane pelvic rotation for the 25 subjects was 1 to 4 inches. The average amount of transverse plane pelvic rotation was 2.4 inches when initially measured. The light electrodes attached to the subject’s iliac crests verified that the observed rotation of the dowel pole was accurate to a variance of $\frac{1}{4}$ to $\frac{1}{2}$ inch.

Following the three minute trunk-stabilization exercises, each subject was re-measured at shoulder-width stance. The dowel pole was visually deemed to be parallel to the lines on the vinyl mat for all 25 of the subjects. This parallel transverse pelvic plane position at shoulder width stance was also present with changes in stance width at 2 inches wider and 2 inches narrower. These observations were corroborated by measurement of the light electrode positions attached to the iliac crests.

Nineteen of the original 25 subjects were seen in follow-up in the field. The vinyl
mat and dowel pole used in the biomechanics lab was used to measure each of the 19 subjects. All 19 subjects had returned to their same baseline measurements at follow-up inclusive of changes in transverse plane pelvic rotation at a shoulder width stance, 2 inches narrower than shoulder width and 2 inches wider than shoulder width. Upon completion of the 3-minute exercise program, each subject again showed total correction of pelvic rotation to parallel to the vinyl mat lines as measured by the dowel pole in all stance widths.

Seventeen of the 19 follow-up subjects were available for a second follow-up at 8 hours. The second follow-up showed that in all 17 subjects, the transverse plane of the pelvis was still parallel to the lines on the mat at shoulder width, 2 inches wider and 2 inches narrower.

Twelve of the 17 subjects from the 8 hour follow-up were available for a third follow-up at 24 hours. Those 12 subjects had returned to their same baseline measurements at follow-up, inclusive of changes in transverse-plane pelvic rotation at a shoulder width stance, 2 inches narrower than shoulder width and 2 inches wider than shoulder width.

Again, when the 12 subjects in the 24 hour follow-up completed the 3 minute exercise program, each subject again showed total correction of transverse plane pelvic rotation in all stance widths and in their golf set up position without a club.

**DISCUSSION**

This study demonstrates that a parallel-foot position does not necessarily equal a parallel transverse pelvic plane alignment. A recurring theme in golf instruction is to teach golfers to set their hips (transverse pelvic plane) and shoulders parallel to each other in the address position. Many instructors advocate a stance line where the toes, knees, hips and shoulders are parallel to each other and to the target line.

Therefore, when golf professionals use a club shaft or similar object to determine hip alignment based upon a golfer’s stance, their observation is likely not accurate; i.e., stance adjustments, other than parallel to the target line, must be made for the pelvic plane to be parallel (square) to the target line. The elimination of transverse plane pelvic rotation at all stance widths controls this variable for both golf instruction and further research.

When the pelvic plane is square to the stance line in the standing tall, erect posture, further research is possible to determine the variables that impact the pelvic plane in the address position. For example, pilot studies looking at stance width, grip (how a golfer places his hands on the club), grip size, and foot flare all impact the transverse pelvic plane in both a standing tall and the address position. If a golf instructor chooses to set a player’s hips and shoulders parallel to the target line, eliminating transverse plane pelvic rotation as a variable is the first step. Controlling the “natural” rotation of the transverse pelvic plane in the standing tall erect posture, allows for investigation into other factors that contribute to transverse plane pelvic rotation in both the standing tall, erect posture and address position.

The origin of transverse plane pelvic rotation is unknown. The exercises (dead bug) in this research project are meant to target stimulation of the *transversus abdominis* muscle. Further research is indicated to determine the exact physical process creating the change. Electromyography (EMG) studies with electrodes placed
on the pelvis, lumbar and thoracic spine regions before, after and during the exercises are suggested by the authors. Additional research is necessary to determine what muscle group(s) or other soft tissue structures work in concert to produce both the observed pelvic plane rotation and correction.

Based upon the validation of the field measurement system, future researchers may consider using a horizontally lined surface along with the dowel and bungee cord attachment when body markers are not available.

Another observation during the course of other phases of the research protocol showed that the path of a putter, also marked with light electrodes, followed the path of transverse pelvic plane as it passed the frontal pelvic plane in the backstroke and through stroke in 22 of the 25 subjects (Figure 21). Similarly, in 19 of the 25 subjects, during a swing phase of the research protocol with a 6-iron marked with light electrodes, the downswing followed the address position of the pelvic plane [16]. For example, if the transverse plane of the pelvis was rotated left in the address position, the club shaft (shaft plane) followed the left address position of the pelvic plane in the downswing (Figure 22). Further research is also indicated to explore shaft plane and the transverse pelvic plane relationships in both the putting stroke and full swing.

Lastly, research is indicated to determine what set up and motion predisposes the golfer to the least potential for injury. For example, does a stance that is parallel to the pelvic plane, shoulders and target line have the least potential for injury or is it a stance that is square to the target line and the pelvic plane and shoulders parallel left of the target line, etc.?
As a reference for comparison in future research, one inch of transverse pelvic plane rotation is equal to 5 degrees. Thus, the range of transverse pelvic plane rotation for the subject pool in this study was 5 to 20 degrees with an average of 12 degrees.
REFERENCES
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