

An Investigation into Impact Ratio for Putter Club Design and Impact Location

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Purpose

A putt hit with the perfect line but with the wrong speed might still miss the hole due to how the ball slows down and reacts with the terrain of the putting green. The following study investigated the significance of impact location for nine leading club manufactures (See Appendix 1 for specifications) including three blade style, three mallet style and three marketed as having a high moment of inertia (MOI). How does a different impact location on the putter face effect ball speed and does the style of putter have any influence? Speed has a significant effect on putting results and should be considered an important factor when putting at any level (Pelz, 2000). Despite this, the ability to control ball speed can often be overlooked in coaching. The ability to control the speed of the putter head with controlled face aim, along with green reading are all a primary determinant of putting consistency (Karlsen *et al.* 2008). However little or no focus is aimed towards the effect of miss hits and 'clubhead twist', or even the design of the club face material. The purpose of the study was to better understand the role impact location and club design has on the ability to control ball speed and ultimately distance control.

Methods

The Quintic Ball Roll system (Quintic 2016) uses a high speed camera (360fps) to measure a variety of factors including clubhead speed, ball speed, face angle, face rotation and putter twist as a result of impact. Nine different putter designs were used for the study (blade, mallet and high MOI). Nine impact locations were analysed per putter (see Figure 1). Locations 2, 5, and 8 were determined by the manufactures markings indicating the centre. Ten putts were recorded and analysed for each impact location reproduced by the putting robot (Appendix Figure 2). The clubhead was released from the same location for each putter. Clubhead and ball speed, face angle at impact and putter twist were recorded for the nine impact locations, per putter design using the Quintic Ball Roll system.

Results

The first part of the study was to investigate the impact ratio for a centre strike (impact location 5 – Centre, Centre) for all nine putters. The results can be seen in Table 1. Impact Ratio ranged from 1.62 to 1.72.

Putter	Category	Face	Clubhead Speed (mph)	Ball Speed (mph)	Impact Ratio (IR)	Face Angle (Impact)	Face Twist (°)
Odyssey O Works #1Wide	Blade	Micro Hinges	3.70 ± 0.06	6.05 ± 0.09	1.64 ± 0.02	0.08 ± 0.03	0.13 ± 0.02
Bettinardi BB1F	Blade	Milled	3.70 ± 0.07	6.33 ± 0.12	1.71 ± 0.01	-0.03 ± 0.04	0.11 ± 0.04
Evnrroll ER2	Blade	Grooves	3.66 ± 0.04	6.01 ± 0.07	1.64 ± 0.01	-0.10 ± 0.05	0.10 ± 0.04
Odyssey O Works R Line	Mallet	Micro Hinges	3.59 ± 0.03	5.86 ± 0.05	1.63 ± 0.01	0.04 ± 0.03	0.07 ± 0.02
Taylor Made TP Berwick	Mallet	Grooves	3.72 ± 0.06	6.25 ± 0.05	1.68 ± 0.03	-0.02 ± 0.10	0.05 ± 0.04
PING Vault Oslo	Mallet	Grooves	3.62 ± 0.04	6.23 ± 0.08	1.72 ± 0.03	-0.07 ± 0.10	0.07 ± 0.03
Evnrroll ER7	MOI	Grooves	3.71 ± 0.04	6.01 ± 0.07	1.62 ± 0.03	-0.08 ± 0.09	0.14 ± 0.08
Taylor Made Spider Red	MOI	Grooves	3.62 ± 0.05	5.90 ± 0.07	1.63 ± 0.03	-0.06 ± 0.12	0.18 ± 0.09
Ping Sigma G Wolverine T	MOI	Insert	3.59 ± 0.03	6.00 ± 0.05	1.67 ± 0.02	-0.08 ± 0.06	0.08 ± 0.06

Table 1: Average ± S.D Centre / Centre Contact – Impact Point '5'

Discussion

Impact Location 5: The Impact Ratio (IR) is the kinetic energy transferred to the ball from the club head during contact. The IR ranged from 1.72 to 1.62 for centre, centre (location 5) for the nine putters. This variance in ball speed will cause the ball to travel distances and therefore slow down at a different rates, particularly relevant to the golfer on sloping putts. The high MOI putters had on average a higher head weight 365gms \pm 6. The blade style putters had the lowest head weight 351gms \pm 2

A ball speed range of 0.43 mph was reported between the nine different putters for centre impact, despite the Clubhead speed at impact being consistent (3.59 to 3.70 mph). These differences are caused by the material and design of the putter.

9 Impact Locations: Centre, centre (Location 5) was always the highest IR for all nine putters. PING Vault Oslo had the highest IR 1.72, with the lowest value 1.46 (Low, Heel) for the Taylor Made Spider Red. If both putters had a clubhead impact speed of 3.6mph, this would equate to a difference of (6.19 – 5.26) 0.93mph. This result highlights the importance of impact location, 0.93mph on a flat green stimping 10, will travel approximately 3 feet.

There is a perceived notion that blade putters have the least amount of drop in ball speed with miss hits, but a greater horizontal dispersion. In contrast high MOI putters are designed to reduce the horizontal dispersion, but as a consequence there is a lower ball speed from miss hits. The results from this study show that every putter is different. The MOI putters did have the highest percentage drop for miss hits in location 4 and 6 (across the centre line toe to heel), however one particular blade putter had a 14% drop for impact location 9.

As a general observation, centre (high / low and across the face) has the least drop in energy transfer (impact ratio) in all putters. Low on the putter face (as an overall area) has the biggest drop in energy transfer, with low heel (impact location 9) having on average the lowest drop, a drop of 10%.

- **The IR is the kinetic energy transferred to the ball from the clubhead during contact.**
- **Impact clubhead speed has the greatest effect on impact ball speed, but IR will also influence this.**
- **Normally the consistency of the IR is more important than the average.**
- **However, a high IR will cause greater variations in the impact clubhead speed.**
- **IR is effected by the head weight, face technology (inserts, grooves, milling.)**
- **Not every high MOI putter necessarily performs better than a blade for off centre hits.**

Practical Application

Golfers need to be able to consistently control ball speed in order to achieve a consistent end distance. Impact ball speed is directly affected by the impact club head speed. However head weight, face technology and impact location, collectively all have an influence on the IR. Inconsistencies in impact location will cause an inconsistency in the impact ball speed. A consistent strike point is required for a consistent impact ratio regardless of head weight or face technology. A high IR will cause any variations in impact club head speed

to be magnified, however, the speed the ball reacts from the putter face is often a personal preference and one the player often becomes accustomed. If a new face insert is introduced, or even model style may well result in a new IR. As a result this will affect the resultant ball speed and will require adjustment for the player on the putting green. Every putter is different and not every high MOI putter necessarily performs better than a blade on off centre hits. This ultimately requires a player to measure any potential new putter and compare its characteristics to their current putter.

An area for further research is that relating to clubhead twist and the effect this has not only of IR but also the horizontal start direction. During the study, it was noticeable that the different impact locations and models react differently in terms of IR, hence different ball speeds but also increased variations in horizontal start direction. This is an area of further investigation, involving over head cameras to quantify the exact start direction. In addition the effect of high and low strikes on launch angle.

Keywords: putting; strike, impact location, impact ratio, speed, performance

References

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Karlsen, J., Smith, G, Nilsson, J (2008). The stroke has only a minor influence on direction consistency in golf putting among elite players. Journal of Sports Science, February 1st 2008; 26(3): 243-250

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Appendix

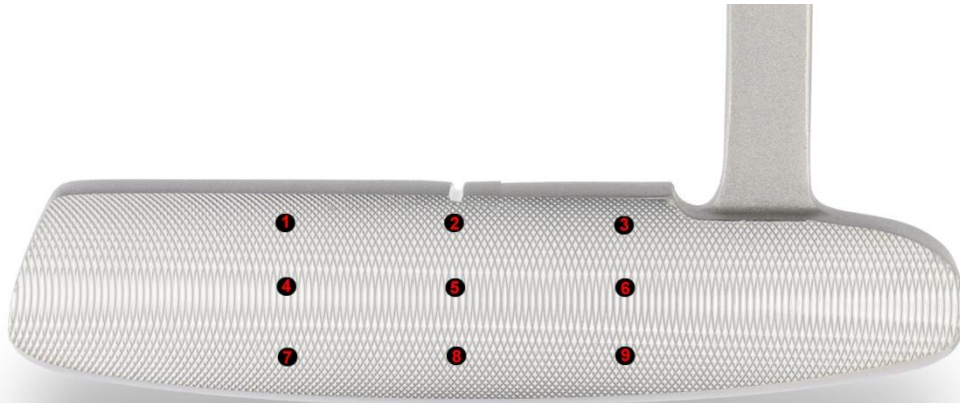


Figure 1: The nine club head impact locations

Please note: Points 2, 5 and 8 are aligned to the club manufactures centre alignment guide on the putter. The toe and heel points are two cms apart from the midline. Points 4, 5 and 6 are in the middle of the face (top / bottom). The top and bottom rows were equally spaced out, depending on putter face depth or the insert depth.

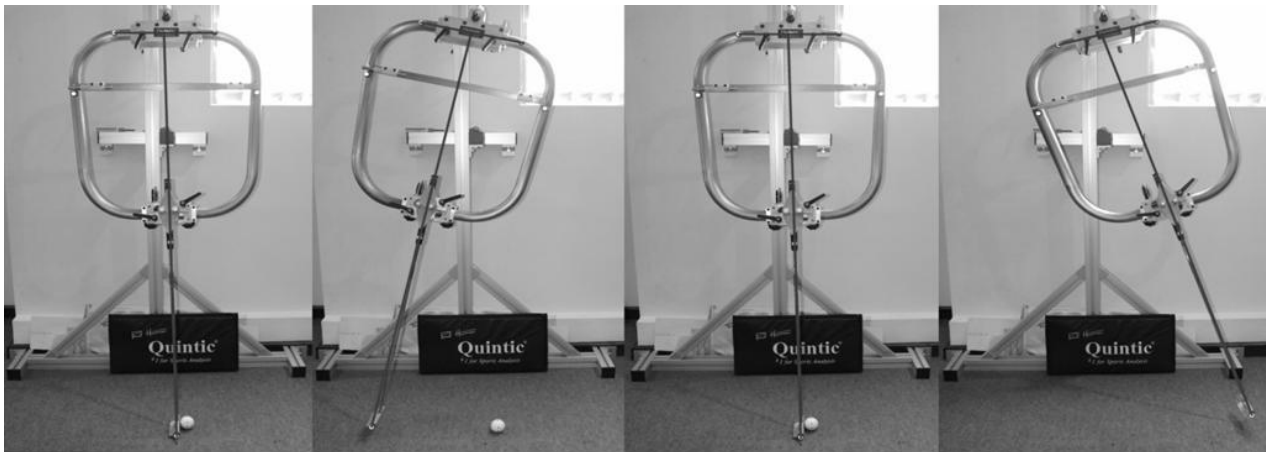


Figure 2: The club head speed was 3mph + 0.03 for each putt reproduced by the putting robot



Figure 3: A visual representation of the impact location (top / middle / bottom)


	Impact Ratio			% Drop Impact Ratio			
		Toe	Centre	Heel	Toe	Centre	Heel
	High	1.56	1.60	1.55	95%	98%	95%
	Centre	1.58	1.64	1.58	96%	100%	96%
	Low	1.52	1.61	1.46	93%	98%	89%

Table (i) : Odyssey O Works #1 Wide – Blade Impact Ratio (IR) and % drop for the 9 Impact locations

100% = Centre, Centre impact location 5. % reduction in IR depending on Impact location (1-9).

Head type: blade / Loft: 3° / Lie: 70° / Hosel: S-neck / Offset: ¾ shaft / Toe hang: 47° / Head weight: 350g

Advertised features: Microhinge technology provides incredible gains in topspin and roll at impact regardless of the stroke. The stainless steel Microhinge plate is co-molded into our Thermoplastic Elastomer Feel Layer, providing great feel and getting the ball into a better roll at impact. The new mallets with toe hang are all designed for players who like to feel the face of their putter rotate more in their stroke.


	Impact Ratio				% Drop Impact Ratio		
		Toe	Centre	Heel	Toe	Centre	Heel
	High	1.61	1.67	1.57	94%	98%	92%
	Centre	1.65	1.70	1.63	97%	100%	96%
	Low	1.61	1.65	1.47	94%	97%	86%

Table (ii) : Bettinardi BB1F – Blade Impact Ratio (IR) and % drop for the 9 Impact locations

100% = Centre, Centre impact location 5. % reduction in IR depending on Impact location (1-9).

Head type: "Anser 2" / Loft: 3° / Lie: 70° Hosel type: long plumbers neck / Offset: ½ shaft / Toe hang: Strong / Head weight: 350g

Advertised features: The BB1, our classic blade-style putter, has received unique cosmetic and performance upgrades for 2018 which includes a neck that has been moved slightly forward towards the sweet spot which promotes less toe hang. The traditional Honeycomb face has been replaced in favour of our aggressive fly mill milling technique, which produces a softer feel at impact. A new Stealth Black finish is complimented with an electric yellow paint scheme, reducing glare and improving aim optics.



	Impact Ratio				% Drop Impact Ratio		
		Toe	Centre	Heel	Toe	Centre	Heel
	High	1.53	1.60	1.52	93%	98%	93%
	Centre	1.62	1.64	1.61	99%	100%	98%
	Low	1.52	1.56	1.48	93%	95%	90%

Table (iii) : Evnroll ER2 – Blade Impact Ratio (IR) and % drop for the 9 Impact locations

100% = Centre, Centre impact location 5. % reduction in IR depending on Impact location (1-9).

Head type: blade / Loft: 3° / Lie: 70° / Hosel type: Single bend / Offset: ½ shaft / Toe hang: Slight / Head weight: 355g

Advertised features: This precise face milling imparts progressively to provide more energy transfer on off-centre putts, this improves distance control to prevent you coming up short on off centre putts. This milling pattern also gears the ball back to the centre, so you hit the sweet spot of the putter for greater consistency.

	Impact Ratio	% Drop Impact Ratio
		

	Toe	Centre	Heel	Toe	Centre	Heel
High	1.51	1.58	1.50	93%	97%	92%
Centre	1.55	1.63	1.56	95%	100%	96%
Low	1.54	1.58	1.48	93%	97%	91%

Table (iv) : Odyssey O Works R Line – Mallet Impact Ratio (IR) and % drop for the 9 Impact locations

100% = Centre, Centre impact location 5. % reduction in IR depending on Impact location (1-9).

Head type: mallet / Loft: 3° / Lie: 70° / Hosel type: Long Hosel / Offset: ½ shaft / Toe hang: Face balanced / Head weight: 350g
 Advertised features: Our Microhinge Insert Technology provides incredible gains in topspin and roll at impact regardless of your stroke. The stainless steel Microhinge plate is co-molded into our Thermoplastic Elastomer Feel Layer, providing great feel and the new geometry of the hinges and urethane together help to get the ball into a better roll at impact.


		Impact Ratio			% Drop Impact Ratio		
		Toe	Centre	Heel	Toe	Centre	Heel
	High	1.53	1.60	1.53	91%	95%	91%
	Centre	1.62	1.68	1.62	96%	100%	96%
	Low	1.52	1.58	1.49	90%	94%	89%

Table (v) : Taylor Made TP Berwick – Mallet Impact Ratio (IR) and % drop for the 9 Impact locations

100% = Centre, Centre impact location 5. % reduction in IR depending on Impact location (1-9).

Head type: mallet / Loft: 3° / Lie: 70° / Hosel type: plumbers neck / Offset: ½ offset / Toe hang: face balanced / Head weight: 350g
 Advertised features: The Berwick putter is perfect for golfers who prefer a face-balanced, mallet style putter with a sleek profile. Created in a precise, rounded shape, this putter includes a single sightline on the back cavity. Complete with a double bend shaft and full shaft offset, this putter provides a straight back, straight through putter stroke. The putter has a new and improved pure insert roll for a better roll, and has adjustable sole weights to set the up the putter for your perfect playable swing weight. To help you stay on track and sink more puts the putter has two sightlines and has Tour validated putter grip to give you maximum feel and touch.


		Impact Ratio			% Drop Impact Ratio		
		Toe	Centre	Heel	Toe	Centre	Heel
	High	1.58	1.66	1.56	92%	97%	91%
	Centre	1.66	1.72	1.64	97%	100%	95%
	Low	1.56	1.64	1.53	91%	95%	89%

Table (vi) : PING Vault Oslo - Mallet Impact Ratio (IR) and % drop for the 9 Impact locations

100% = Centre, Centre impact location 5. % reduction in IR depending on Impact location (1-9).

Head type: mallet / Loft: 3° / Lie: 70° / Hosel type: single bend / Offset: no offset / Toe hang: face balanced / Head weight: 365g
 Advertised features: a smaller mallet with geometric features to frame the ball at address, including a low level sightline. The Vault Oslo features a new True Roll (TR) face technology. This technology uses face grooves that are machined to varying depths to help speed up off-center hits and provide more consistency in your putts. A stainless steel bottom weighting boosts MOI and lowers CG to improve your putting performance.


		Impact Ratio			% Drop Impact Ratio		
		Toe	Centre	Heel	Toe	Centre	Heel
	High	1.51	1.56	1.51	93%	96%	93%
	Centre	1.54	1.62	1.53	95%	100%	94%
	Low	1.50	1.57	1.49	93%	97%	92%

Table (vii) : Evnroll ER7 – MOI Impact Ratio (IR) and % drop for the 9 Impact locations

100% = Centre, Centre impact location 5. % reduction in IR depending on Impact location (1-9).

Head type: mallet / Loft: 3° / Lie: 70° / Hosel type: single bend / Offset: ½ offset / Toe hang: Slight / Head weight: 370g
 Advertised features: This precise face milling imparts progressively to provide more energy transfer on off-centre putts, this improves distance control to prevent you coming up short on off centre putts. This milling pattern also gears the ball back to the centre, so you hit the sweet spot of the putter for greater consistency.


		Impact Ratio			% Drop Impact Ratio		
		Toe	Centre	Heel	Toe	Centre	Heel
	High	1.53	1.60	1.50	94%	98%	92%
	Centre	1.55	1.63	1.51	95%	100%	93%
	Low	1.52	1.58	1.46	93%	97%	89%

Table 9 : Taylor Made Spider Red – MOI Impact Ratio (IR) and % drop for the 9 Impact locations

100% = Centre, Centre impact location 5. % reduction in IR depending on Impact location (1-9).

Head type: mallet / Loft: 3° / Lie: 70° / Hosel type: long plumbers neck / Offset: ½ shaft / Toe hang: Moderate (38°) / Head weight: 355g
 Advertised features: High MOI for increased forgiveness and stability. Smooth crown, no sightline, and short slant neck hosel for Spider Tour Red and Spider Tour Black. Long sightline, double bend shaft and face balanced head for Spider Tour Platinum. Spider Tour Red has a Pure Roll™ Surlyn insert for softer sound and feel. Spider Tour Black has a Pure Roll™ 80/20 insert for firmer sound and feel. Vibration-dampening foam for consistent sound and feel.


		Impact Ratio			% Drop Impact Ratio		
		Toe	Centre	Heel	Toe	Centre	Heel
	High	1.50	1.62	1.52	90%	97%	91%
	Centre	1.54	1.67	1.55	92%	100%	93%
	Low	1.48	1.57	1.49	89%	94%	89%

Table 10 : Ping Sigma G Wolverine T – MOI Impact Ratio (IR) and % drop for the 9 Impact locations

100% = Centre, Centre impact location 5. % reduction in IR depending on Impact location (1-9).

Head type: mallet / Loft: 3° / Lie: 70° / Hosel type: double bend / Offset: ½ shaft / Toe hang: face balanced / Head weight: 370g
 Advertised features: A high-energy Pebax elastomer insert behind the anodized 6061 aluminium face provides a soft feel without slowing ball speed, ensuring full-face forgiveness and consistent distance control. True Roll Face Technology supplements putting touch for improved consistency and fewer three-putts.