

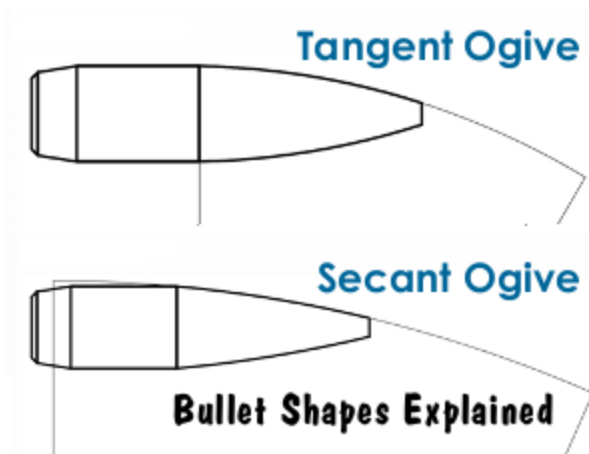
## Characteristics of Different Bullet Ogive Designs

By Bryan Litz

In discussions of ballistics, you'll see references to "tangent" and "secant" bullet shapes. We know that, for many readers, these terms can be confusing. To add to the confusion, bullet makers don't always identify their projectiles as secant or tangent designs. This article provides a basic explanation of tangent and secant designs, to help you understand the characteristics of both bullet shapes.

### Tangent Ogive vs. Secant Ogive vs. Hybrid

Most match bullets produced today use a tangent ogive profile, but the modern VLD-style bullets employ a secant profile. To further complicate matters, the latest generation of "Hybrid" projectiles from Berger Bullets feature a blended secant + tangent profile to combine the best qualities of both nose shapes. The secant section provides reduced drag, while the tangent section makes the bullet easier to tune, i.e. less sensitive to seating depth position.



### How Bullet Ogive Curves are Defined

While the term "ogive" is often used to describe the particular point on the bullet where the curve reaches full bullet diameter, in fact the "ogive" properly refers to the *entire* curve of the bullet from the tip to the full-diameter straight section — the shank. Understanding then, that the ogive is a curve, how is that curve described?

The ogive of a bullet is usually characterized by the length of its radius. This radius is often given in calibers instead of inches. For example, an 8 ogive 6mm bullet has an ogive that is a segment of a

circular arc with a radius of  $8 \times .243 = 1.952$ ". A .30-caliber bullet with an 8 ogive will be proportionally the same as the 8 ogive 6mm bullet, but the actual radius will be 2.464" for the .30 caliber bullet.

For a given nose length, if an ogive is perfectly tangent, it will have a very specific radius. Any radius longer than that will cause the ogive to be secant. Secant ogives can range from very mild (short radius) to very aggressive (long radius). The drag of a secant ogive is minimized when its radius is twice as long as a tangent ogive radius. In other words, if a tangent ogive has an 8 caliber radius, then the longest practical secant ogive radius is 16 calibers long for a given nose length."

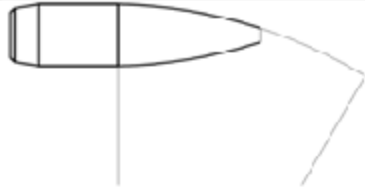
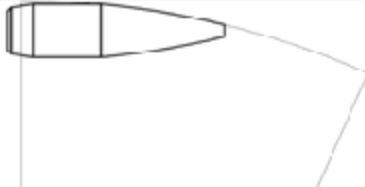

[http://www.youtube.com/watch?v=N4RpQtyI\\_p4](http://www.youtube.com/watch?v=N4RpQtyI_p4)

### Ogive metrics, and Rt/R

There is a number that's used to quantify how secant an ogive is. The metric is known as the Rt/R ratio and it's the ratio of the tangent ogive radius to the actual ogive radius for a given bullet. In the above example, the 16 caliber ogive would have an Rt/R ratio of 0.5. The number 0.5 is therefore the lowest practical value for the Rt/R ratio, and represents the minimum drag ogive for a given length. An ogive that's perfectly tangent will have an Rt/R ratio of 1.0. Most ogives are in between an Rt/R of 1.0 and 0.5. The dimensioned drawings at the end of my Applied Ballistics book provide the bullets ogive radius in calibers, as well as the Rt/R ratio. In short, the Rt/R ratio is simply a measure of how secant an ogive is. 1.0 is not secant at all, 0.5 is as secant as it gets.

**Hybrid Bullet Design — Best of Both Worlds?**

Bryan Litz has been developing a number of modern “Hybrid” design bullets for Berger. The objective of Bryan’s design work has been to achieve a very low drag design that is also “not finicky”. Normal (non-hybrid) secant designs, such as the Berger 105gr VLD, deliver very impressive BC values, but the bullets can be sensitive to seating depth. Montana’s Tom Mousel has set world records with the Berger 105gr VLD in his 6mm Dasher, but he tells us “seating depth is critical to the best accuracy”. Tom says a change of .005” in seating depth “can cause the group size to increase substantially”. In an effort to produce more forgiving high-BC bullets, Bryan Litz has developed a hybrid tangent/secant bullet shape. This is explained in the illustration below.

Tangent Ogive		Secant Ogive	
			
Strength	Weakness	Strength	Weakness
Smooth juncture with bearing surface is good for self aligning the bullet into the riflings, thereby making the bullet less sensitive to seating depth.	The tangent ogive has more drag (lower BC) than a secant ogive (VLD) of the same length.	Lower drag (higher BC) than a tangent ogive of the same length.	The abrupt juncture between the bearing surface and ogive is not good for self-aligning the bullet in the riflings so this shape is quite sensitive to seating depth.
Hybrid Ogive			
		<p>The Hybrid ogive combines the Strengths of both the Tangent and Secant ogives, without suffering either of the weaknesses.</p> <p>The hybrid ogive is tangent to the bearing surface where it contacts the riflings. This aids the bullet in self-aligning with the bore and making it less sensitive to seating depth.</p> <p>Forward of the point where the riflings engrave the bullet, the ogive transitions into a longer radius (lower drag) ogive which is good for drag reduction.</p> <p><b><i>The end result of the hybrid ogive is a bullet with the low drag/high BC of a secant ogive (VLD) which also accomplishes precision easily in many rifles because it's not sensitive to seating depth.</i></b></p>	