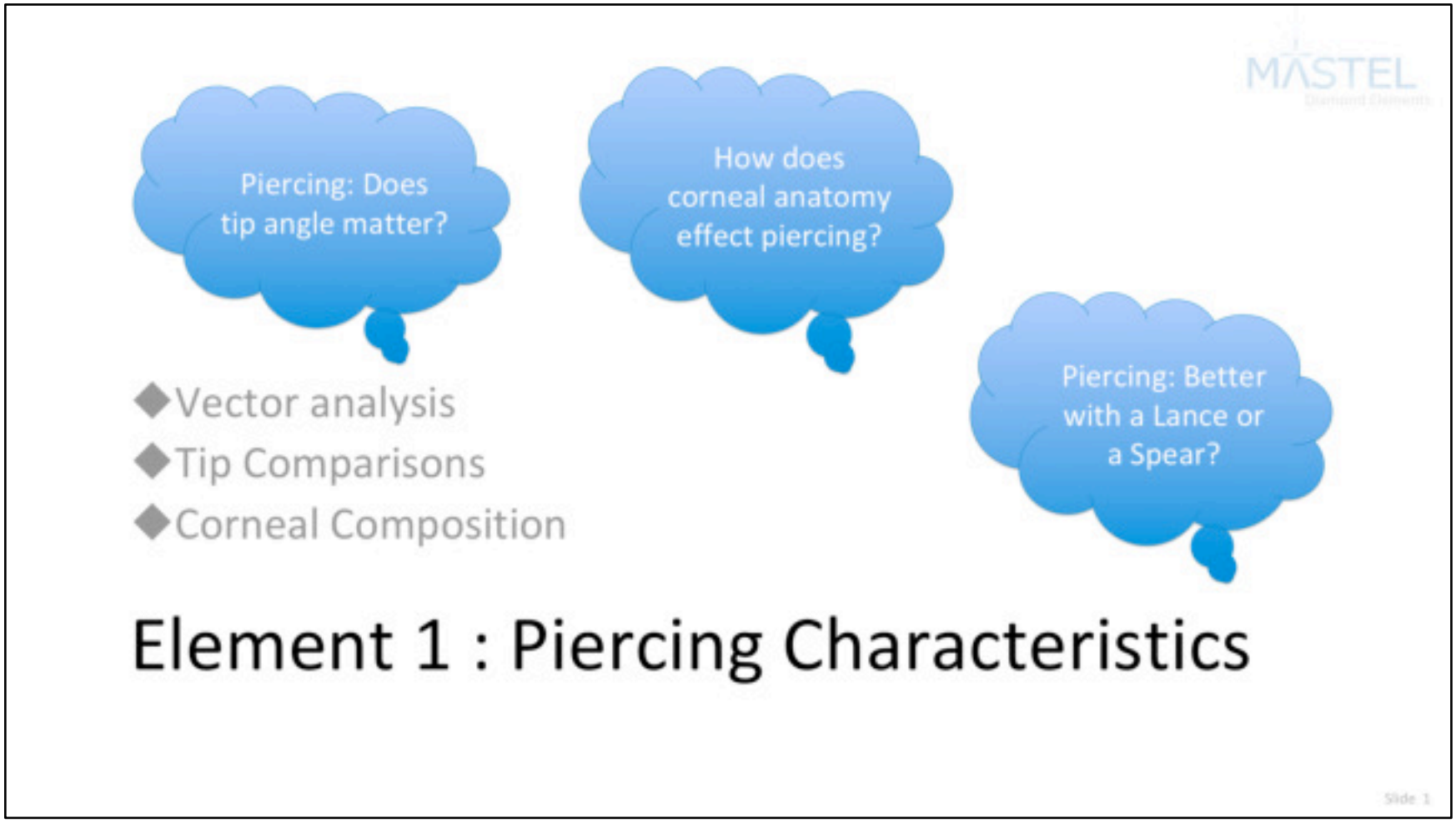
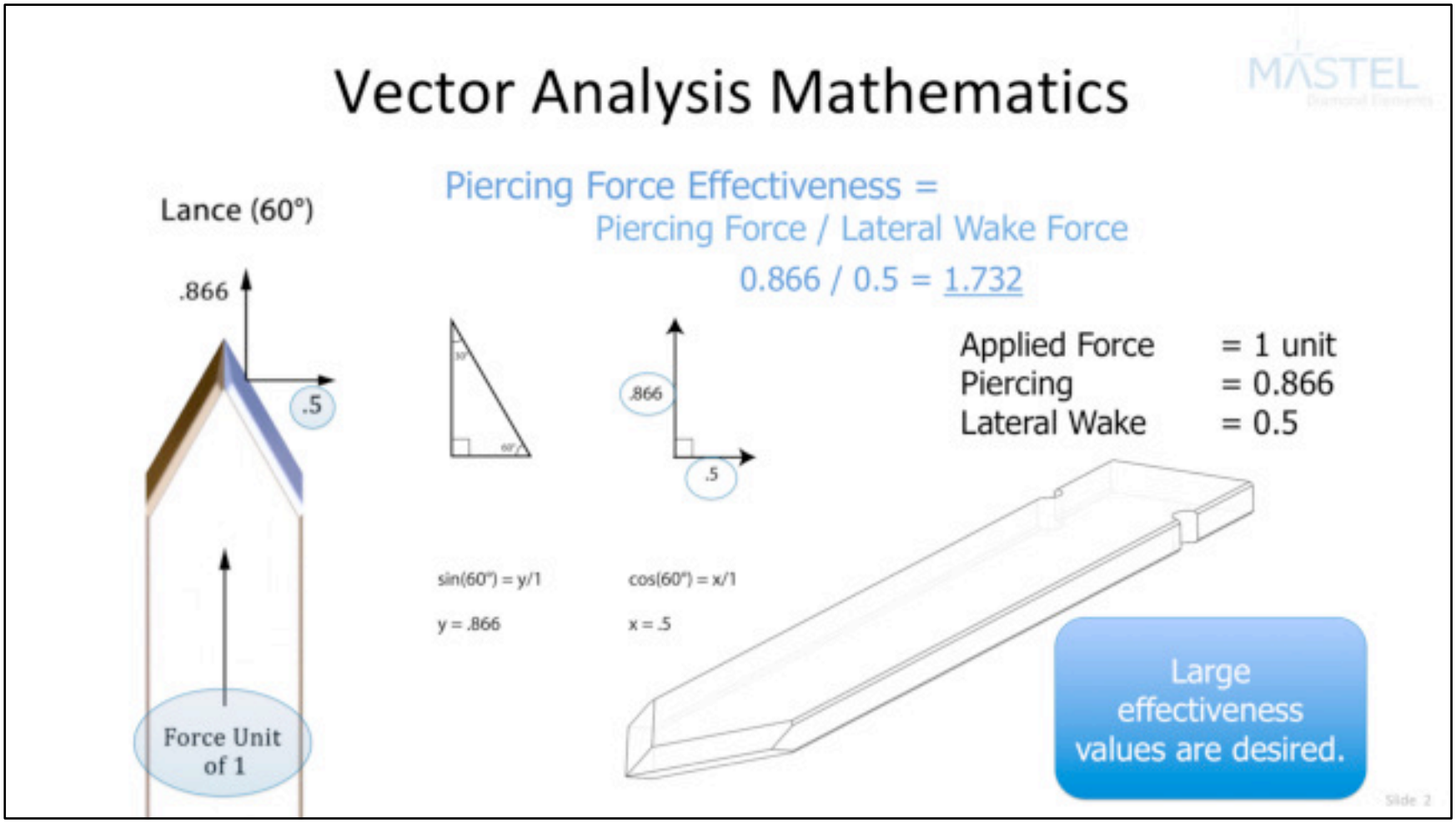
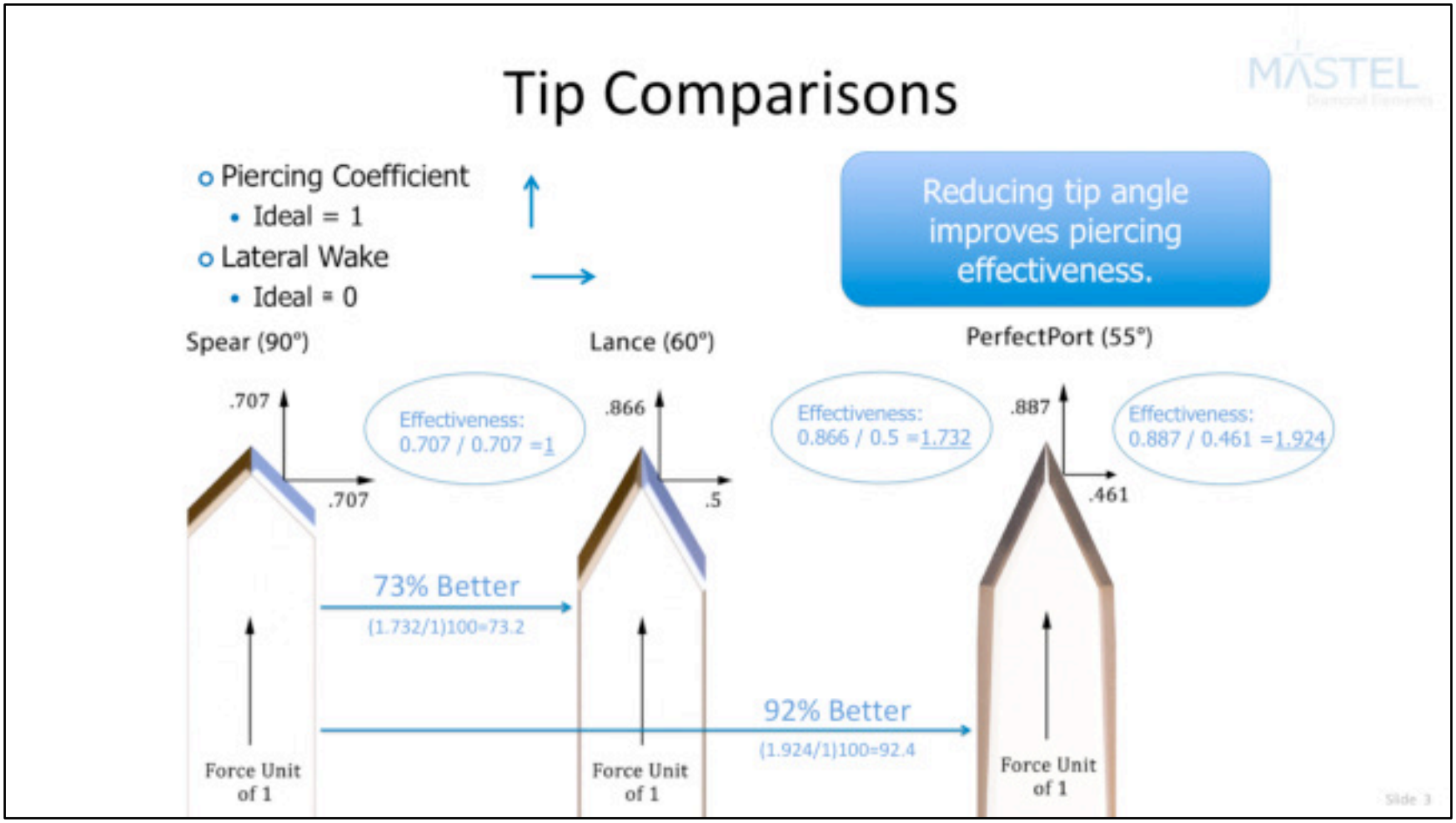
Welcome to the Diamond Elements series by Mastel. In this series, we hope to assist our clients in making more informed scalpel purchases. We aim to promote the understanding of blade design in relation to wound architecture, and to encourage customers to purchase lances in place of spears. This presentation covers Element 1, Piercing Characteristics.



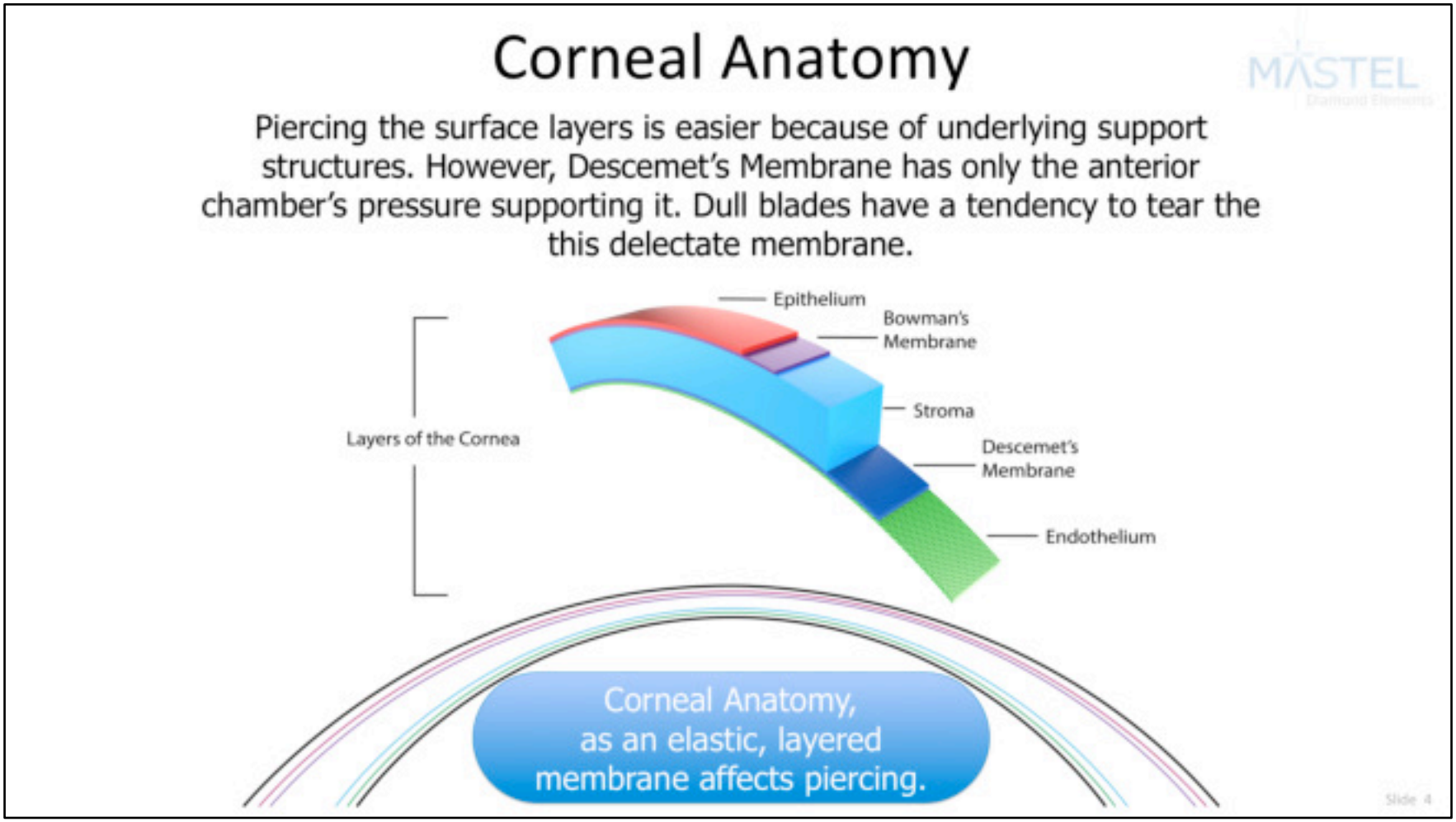
We will begin by using some basic geometry in order to contrast the effectiveness of 3 common tip angles: 90°, 60°, and the new Mastel PerfectPort, which is 55°. Later, we will demonstrate how different blade configurations can inducing corneal stress.



Here we are showing a 60° lance tip with symmetric edges and facets – note, we are not referring to the side edges or margins. Now, imagine a force unit vector directed upward. If we were to have a "perfect" blade, the force at the tip would concentrate at an infinitesimally small point. However, in reality, this is not the case. Due to blade geometry, part of the original force is diverted laterally into what we call the "lateral wake force." So due to blade geometry, we are left with two resultant vectors: one in the same direction as the original force (the piercing force) and one directed laterally (the lateral wake force). Dividing the piercing force by the lateral wake force will give you the "piercing force effectiveness." We can now use the piercing force effectiveness to compare the spear, lance and PerfectPort mathematically. As you can see



Here we are looking at three different piercing tips: spear, lance and the Mastel PerfectPort. As you can see, by decreasing the tip angle, the piercing force effectiveness increases. A lance is 73% better than a spear, and the PerfectPort is 92% better than a spear.



Let's take a brief look at how corneal anatomy affects piercing. The cornea, as you are familiar with, is a layered structure covering a liquid chamber. When piercing the cornea, you apply compressive stress to the tough membrane's outer surfaces which act as an elastic membrane. Once your scalpel has advanced to the point of Descemet's membrane, you switch from compressing a material with support, to pushing against a fluid. By using a spear, a dull blade, or both, you inadvertently cause higher resistance to piercing and are essentially causing tension on Descemet's. Worst case scenario, this can tear Descemet's away from the other layers of the cornea.

Analysis of the Force Exerted on an Elastic Membrane by a Puncture Device.

Assumptions:

1. The deflection of the membrane can be modeled as a simple parabola.

2. The distance over which the load is distributed is equal to the distance between the origin and the point on the parabola that is equal to ½ Θ.

$$d = \frac{p}{\tan(90-\theta/2)} * \sqrt{\frac{1}{[\tan(90-\theta/2)]^2 + 4}}$$

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When piercing an elastic material such as Descemet's, deflection occurs before penetration. This deflection can be modeled to determine the total distance over which the blade's force is distributed.

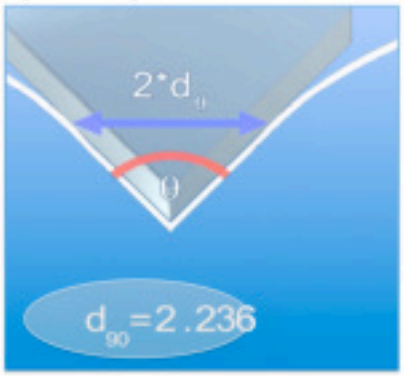
Comparison of Force Distribution Between a 90° Spear Tip and a 60° Lance Tip.

Formula:

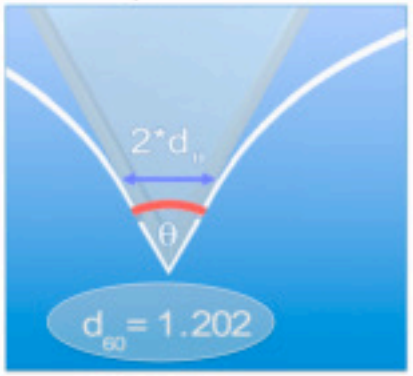
$$d = \frac{p}{\tan(90-\theta/2)} * \sqrt{\frac{1}{[\tan(90-\theta/2)]^2 + 4}}$$

1. Apply the formula to the tip angles to calculate distribution lengths of:
   - ✓ 2.236 – Spear
   - ✓ 1.202 – Lance
2. Compare by ratio:
   - ✓ $\frac{d_{60}}{d_{90}} = \frac{1.202}{2.236} = 0.538$
   - ✓ The piercing force of a Lance's 60° tip is distributed across approximately half (54%) that of a Spear's 90° tip.

Spear Tip θ = 90°

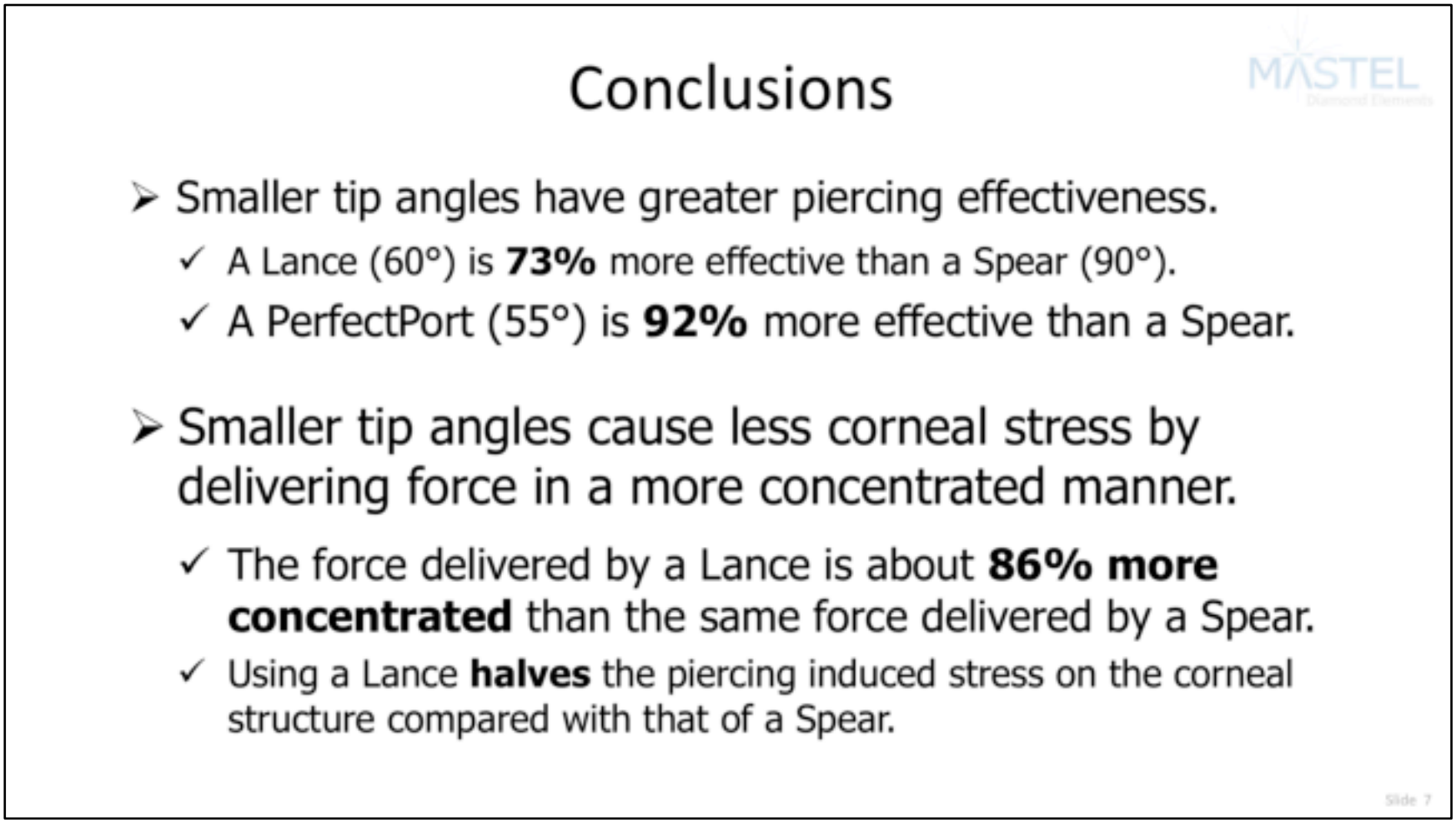


Lance Tip θ = 60°

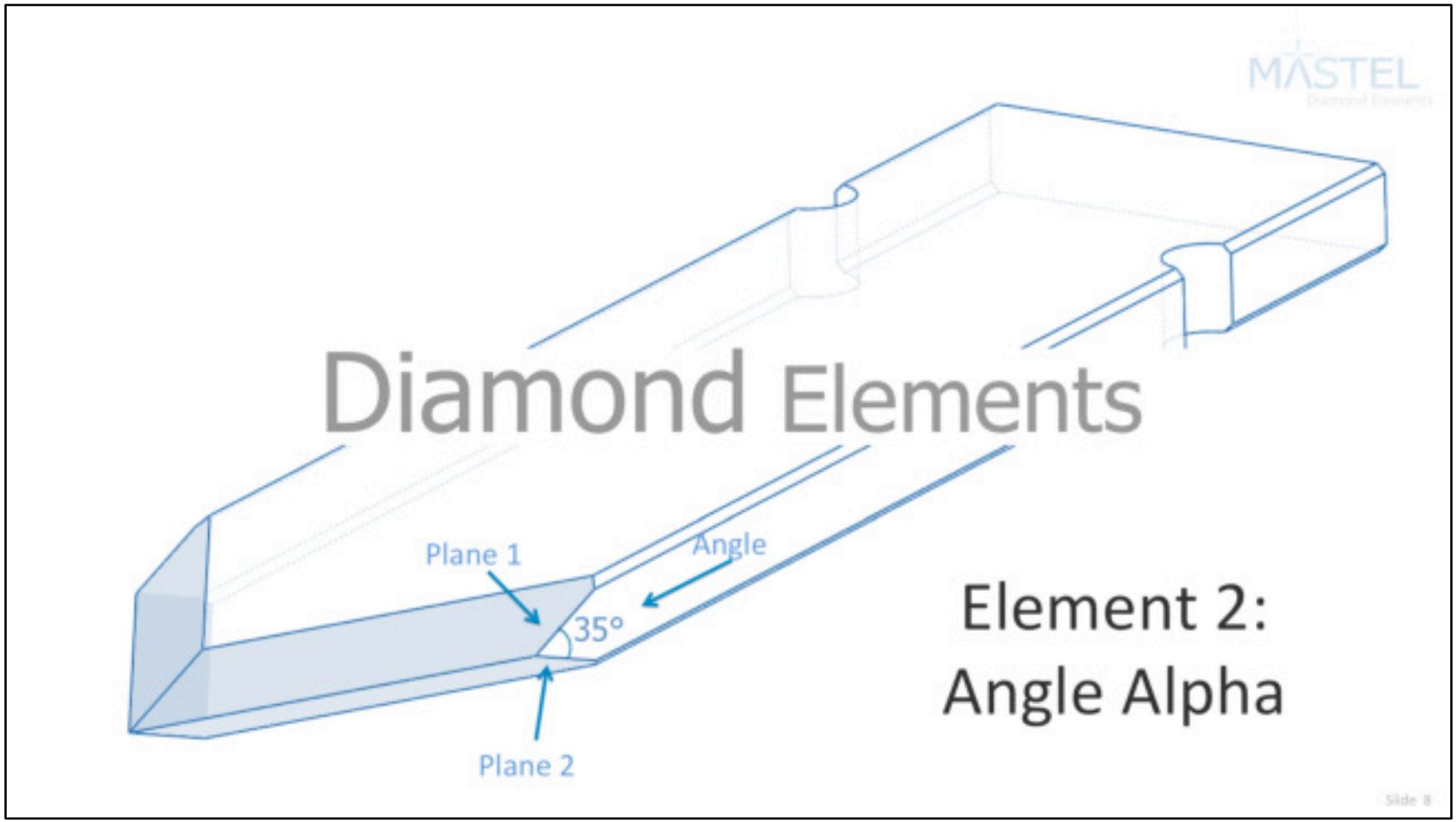


3. Calculate the force concentration when applying 1 unit of force:
   - ✓ Force → Length % → $\frac{1}{0.538} = 1.859$
   - ✓ The force delivered by a Lance is about 86% more concentrated than the same force delivered by a Spear.

Here we compare the distances over which the force is distributed for a 90° spear and a 60° lance. Upon calculation, you will find that a the lance **pierces only half of the tissue** compared with that of a spear does. You will also find that the force is 86% more concentrated. This means that using a Lance **cuts in half** the piercing induced stress on the corneal structure.



In conclusion, we have found that smaller tip angles have greater piercing force effectiveness and cause less corneal stress by delivering a more concentrated force.



This concludes Diamond Elements 1. In Diamond Elements 2, we will discuss angle alpha as it relates to wound margins.