The power of precision

Author: Claus Schendell, Germany

Over the past 25 years of manufacturing, I have been asked many questions regarding design, material and manufacturing techniques of orthodontic brackets. Each time you ask me a question, I realise that the design and manufacturing end of orthodontics must seem like a top secret file kept safely hidden away. That can leave you, the orthodontist, dazed and confused by the varying array of brackets on the market. What makes them different, how do you choose what is best for you and your practice?

The importance of the intimate fit

In orthodontics, placing maximum prescription arch wires in a preadjusted bracket is designed to produce three-dimensional, tooth-moving forces (Fig. 1). These forces can only be created as a result of an intimate fit of the wires into the bracket slot, any gap between these components will result in incomplete transmission of the bracket prescription to the tooth and its supporting tissues (Fig. 1).

We are not all the same

This intimate fit has proved difficult to achieve by many metal injection moulding (MIM) manufacturers. Numerous scientific studies have discovered and reported inaccuracy of the orthodontic bracket slot and the negative influence on orthodontic treatment (Fig. 3).

Every year for the past 10 years, I have selected brackets from around the world and tested them for accuracy, always in an effort to improve my technique or simply to see how others were progressing.

I tested the following simple characteristics (Fig. 4):

A. Is the slot accurate?
B. Are the walls of the slot parallel?
C. Are the corners 90 degrees?

I was always ready to discover that perhaps new manufacturing methods were proving promising. Year after year, measurements of MIM brackets produced consistently unsatisfactory inaccurate results. The majority of MIM brackets during my yearly measurement study continuously measured larger than what was reported by the manufacturers. With a smaller percentage measuring smaller, this proved later in my research to be a twofold problem.

1. MIM manufacturing processes are notoriously difficult to manage and control, precision and consistency of each run varies considerably.
2. Bracket and tube dimensions of +/- 3 degree tolerance are acceptable benchmarks by many MIM manufacturers and are considered as sufficiently adequate (Fig. 2).

These values have been clinically analysed and have proven to have a profound influence on torque expression, as reported in numerous clinical publications (Fig. 3).

It is not by accident that within the world of engineering, CNC Milling dominates high-tech products, high-end watches, Formula 1, and aerospace engineering. Every step can be precisely reproduced over...
and over with the identical velocity, feed and location, without any varying components, including human fatigue. This control enables me to produce bracket slots less than a thousandth of an inch, every run and every year for the past 25 years.

For orthodontists striving for excellence, it is important to understand that different manufacturing techniques produce different results. Avoid the mindset that all bracket systems are more or less the same. Physical principles always stay the same

Inaccurate slots and inaccurate geometry will result in an incomplete transmission of the bracket prescription—it is simple physics. Movement of teeth requires application of forces, and periodontal tissue responds to these forces. Force mechanics are governed by physical principles such as the laws of Newton and Hooke.

Newton’s Laws
- The law of inertia
- The law of acceleration
- The law of action and reaction

What does inaccuracy mean to you?

Inaccuracy within the bracket slot is fully experienced when three-dimensional control is required. For example, during a case when you require incisor inclination correction, additional root torque would need to be added to overcome the inaccurate slot. Sadly orthodontists have come to accept, and fully expect oversize slots and lack of precision within the bracket system they use. However accepting this lack of precision as something that can’t be controlled is incorrect.

You should know how to solve these unexpected tooth movements, but you should not have to due to manufacturing inadequacies. I always liked Alexander’s simple explanation regarding the clinical torque problem, for every 0.001 inch of freedom between the archwire and the vertical bracket slot, approximately 5 degrees of effective torque is lost (Fig. 3). Think about when you apply this explanation to brackets with single digit torque values manufactured with inaccurate slot sizes, they have little, if any, advantage over a standard edgewise bracket.

Physics helps you choose

The principals of physics will never change; if your slot is inaccurate it will produce inaccurate results. This foundation of knowledge will help you navigate your way through the many bracket choices available in the market.

Accuracy within the slot is just one of the benchmarks met during the manufacturing of orthodontic brackets, but we cannot underestimate the significant role it plays for you, the orthodontist.

My role and goal as an engineer and manufacturer is to provide you with true and accurate tools, eliminating the guess work and need to always compensate for a lack of precision, and enabling you to achieve optimal tooth movement and high-quality predictable results (Fig. 5).

References
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contact

Dipl. Ing. Claus Schendell
President of Adenta GmbH
Adenta GmbH
Gutenbergstraße 9
82205 Gilching
Germany
info@adenta.com
www.adenta.com