



## Maxillary and Mandibular Arch Forms

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Accepted on: 20-07-2016; Finalized on: 30-09-2016.

### ABSTRACT

The search for a universal ideal arch form has been one of the most persistent but elusive tasks that orthodontic researchers have pursued. The idea of individualizing arch forms from the original mandibular and maxillary arch has become more very popular and acceptable in past few years. With the continuing development of computer-assisted analysis, this approach of custom designing arch forms may provide the optimum solution for accurately describing the ideal orthodontic arch form for each case.

**Keywords:** Maxillary, mandibular, arch form, Orthodontics.

### INTRODUCTION

The achievement of a stable, functional, and esthetic arch form has long been one of the prime objectives of orthodontics. Consideration of the arch form is of paramount importance, because it is imperative that the arch form should be examined before embarking upon the treatment as this gives valuable information about the position into which teeth can be moved if they are to be stable following treatment.

Several Orthodontics prefer a single form for all malocclusions.

Now, the arch form is adopted based on maximum function and close to perfect aesthetic as per the orthodontists' opinion.

With the exponential use of computers and advancing technology, the approach of custom designing arch forms have gained importance and may provide the optimum solution for accurately obtaining the ideal orthodontic arch form, thus catering to each individual's aesthetic and function.

### History

Since the beginning of orthodontics, many dentists had tried to identify "Ideal arch form" which will be suitable for a large part of the population.

Shapes investigated were based on the mathematical formulae which included cubic spline, conic section and polynomial function.

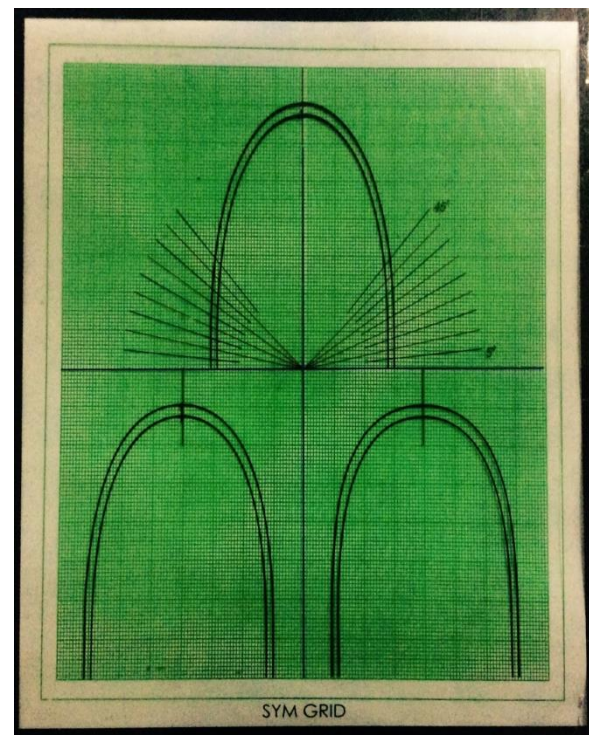
Begole<sup>1</sup> devised a method of arch form development using a mathematical principal, in which arch is shaped by forming a cubic spline curve.

These shapes proposed by different people have been questioned for their validity thus receiving a mixture of acceptance and criticism.

However, with time, the need for a custom arch form that fits each individual's need came into light.

### Basic Arch Forms

Chuck in 1932<sup>2</sup> classified arch forms as tapered, square and ovoid, which constitute the basic arch forms.



**Figure 1:** Template for classification of arch forms: Ovoid, Tapered, Square

### Ovoid Arch Forms

Being the most preferred arch form, it results in minimal post-treatment relapse. It shows a greater intercuspal distance than tapered form.

### Tapered Arch Forms

It has the narrowest intercanine width and is useful early in treatment for patients with narrow, tapered arch forms, especially in cases with gingival recession in the canine and premolar regions.<sup>3</sup>

### Square Arch Forms

For patients with broad arches, this is used. The square form is useful in maintaining expansion in upper-arch after rapid expansion.

When superimposed, the three shapes vary mainly in intercanine and inter-first-premolar width, giving a range of approximately 6 mm in this area.

### Other Arch Forms

#### Bonwill-Hawley Arch Form

With the need for custom arch forms, came the earliest method of measuring arch length and arch width was given by Bonwill in 1887<sup>4</sup>. He used three anatomical landmarks in mandible and constructed a triangle. By using mathematical geometry, shape, size and position of each tooth was approximated.

This popular concept was modified in 1905, by Hawley where he combined the width of six anterior teeth to serve as the radius of a circle determined by combined width of the lower incisors and canines, with the premolars and molars aligned, with the second and third molars turned toward the center. From this circle he constructed an equilateral triangle, with base representing the intercondylar width. The radius of the arch varied on the size of the anterior teeth, so that arch dimensions differed as a function of tooth size, but arch form was constant for all individuals.

This construction is what is popular to this day as the Bonwill-Hawley arch form.

#### Criticism

Chuck stated that the Bonwill-Hawley arch form, contrary to its purpose, was not suitable for every patient and thus could not be used for construction of individualized arch forms.

#### Currier and Radiographs

Currier<sup>5</sup> used radiographs of casts delineated the dental arch morphology with the aid of a computer. It showed that elliptical shape is a better fit got maxillary and mandibular arch than parabola in comparison.

#### Pont

Pont's index<sup>6</sup> was established by Pont in 1909 to predict maxillary dental arch width from the sum of the mesiodistal diameters of the four maxillary incisors.

#### Catenary Curve Concept

Introduced in 1977, this concept was influenced by the catenary curve which is the shape of loop of chain when it is suspended by hooks<sup>7</sup>. A cantenometer is used for estimating the arch perimeter and was showed by Musich<sup>8</sup>. It is used to explain arch form of lower arch.

Given by Schulhof, the length and width between supports determines precise shape of curve. When width across first molars is used to establish posterior

attachments, a catenary curve fits the dental arch form of premolars canine-incisor segment of arch well.

#### Brader Arch Form

In 1972, Brader<sup>9</sup> used mathematical model of arch form based on trifocal ellipse.

$$PR = C$$

where P is Pressure in gm/cm<sup>2</sup>,

R is radius of curvature of elliptic curve at the pressure site in mm

C is mathematical constant.

#### Polynomial Function

Although it was first given by Lu KH<sup>10</sup>, Ferrario<sup>11</sup> reconstructed maxillary and mandibular arches by a fourth-order polynomial and a 'mixed' elliptical (in anterior teeth), plus parabolic (post-canine teeth) interpolation of buccal cusp tips (central incisor to second molar). It was recorded that the curves were simple and can be used for a mathematical view of dental arches in non-patients.

#### Beta Arch Forms

Braun<sup>12</sup> in 1998 said that the human arch form could be portrayed by a complex mathematical formula, known as beta function. It was done so by using a computer curve fitting program where in measurements of dental arches was entered. The model was defined by depth and width of the dental arch at second molar region.

When using this 'beta' function model, is width increased by 1mm, then the depth also increased by 1.5mm, which results in an accurate equation of the dental arch form.

In addition, it will be an excellent generalized equation of the maxillary and mandibular arch shapes for each of the Angle classifications of occlusions.

#### Cubic Spline Curve

A knot is a point through with the curve passes through to generate different curves. The cubic spline curve consists of separate cubic polynomial segments connecting a series of knots. Begole<sup>1</sup> found that the cubic spline curve fit the arch forms of well aligned dental arches with minimal error and that asymmetry of the arch had no effect on accuracy of fit. Any mathematical formula that is accurate in predetermining arch form will have to account for the many nuances and variations individuals have, and to date, none of the formulae offered have done that.

#### Laser Mapping

Another concept being developed by Syrinx Technologies, Texas<sup>13</sup> since 1976 is to place brackets on teeth after which laser mapping is done to establish the arch form and the 3D data is transferred to a computer for storage and usage. After the clinician decides the direction the teeth are to go, individually designed arch wire can be



fabricated. This methods of arch wire formation through CAD-CAM technology and use of custom brackets for each tooth are the gateway to simplifying procedures.

### CONCLUSION

The basic principle of arch form in orthodontics is that within reason, the patient's original arch form should be preserved. There is no generalised, universal arch form as each arch form is a unique expression of individual development. Thus, a study on arch forms is an important aspect of diagnosis and treatment planning.

Study concluded that no generalized, universal arch form seems to be applicable as it was proved that arch form is the unique expression of individual development and probably no universal design will ever be able to account for the many small, but significant, variations in the arch shape of individuals.

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Source of Support: Nil, Conflict of Interest: None.

