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**Original Research Article**

# Clinical Technique to Calculate Pressures in Interproximal Dental Points

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**Abstract:** The adjustment of the interproximal contact points (N) is important to avoid caries, periodontal problems, and halitosis. When this pressure is evaluated, a correct restoration can be made with composite or prosthesis in those points. A metal strip (6 mm wide and 0.03 mm thick) is placed interproximal between adjacent teeth and attached to a dynamometer through a Tofflemire matrix holder. The formula to use is $N = F_d / 2\mu$. The dynamic force of friction ($F_d$) is given by the dynamometer when the strip begins to move between the teeth. A coefficient of friction ($\mu$) for wet enamel-steel metal of 0.176, previously calculated, is used. In this way, to measure adjustments of interproximal points we use the formula $N = F_d / 0.352$. Electronic experimental instruments are much more complicated to use than the instrument described here. The materials used are for daily use in any dental clinic and it is easy to use. The coefficient of friction depends on the humidity of the surface, but here the natural saliva of the patient is used as a lubricant. This simple technique allows the measurement of the fits of interproximal contact points so that dental restorations can be improved at those points.

**Keywords:** Teeth, pressure, interproximal, dynamometer, friction.

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## INTRODUCTION

"Interproximal contact point" is defined as the area of one tooth that is in contact with the adjacent tooth. Many authors talk about the importance of keeping the interproximal contact points closed, so that there is no impaction of food and thus avoid dental caries, periodontal disease, halitosis, occlusion failure, and the undesirable displacement of teeth [1-8]. Contact points are also important to maintain and stabilize the dental arch [8]. A higher frequency of food impaction has been reported when the interdental separation was between 150-200 micrometers [9]. Orthodontists are the ones who have studied the friction of the arches and the brackets they use in their treatments. They point out that if the pressure at the point of contact is excessive it can cause undesirable movements [10-13]. In general, the adjustment of the interproximal contact point is generally evaluated with the use of dental floss (waxed or not), but this method does not give precision about the pressure that exists at that point and is quite subjective [1, 3, 5-8]. In other cases, it has been evaluated by inserting metal strips with different thicknesses [14]. Some authors consider an optimal contact fit when a 50-micrometer thick stainless steel strip is inserted with some resistance, and a 110-micrometer thick strip without resistance [15]. When the space between adjacent teeth is observed under a microscope, there is a distance of 3-21 micrometers and this space disappears when clenching during the bite [15, 16].

Two theories have been established to explain the fit of contact points [17]:

- Compressive theory: a tooth touches another tooth in a compressive state.
- Resistance theory: the size and number of teeth determine these values.

It has also been thought to be multifactorial, influencing parafunctional habits, bruxism,

clenching (nocturnal and daytime), occlusal discrepancies, malposition of teeth, post-orthodontic treatment, iatrogenic dentistry (poorly made crowns or fillings) [6, 18].

Several authors highlight the need to achieve good interproximal contact points during composite restorations. For this, they use different types of matrices [4, 14, 19], as well as modifications in the composition of the restorative material, to reinforce these contact points [1, 2]. It is advisable to use a sectional matrix with a ring to make these restorations [2].

In addition, a decrease in the fit of the interproximal contacts between a fixed prosthesis on implants and adjacent teeth has been described as time passes [20]. This could give higher pressure on the load-bearing structures [21]. For this reason, some authors indicate the need to adjust the contact points in the laboratory, before cementation [6, 8].

Given the importance of knowing the interproximal pressures between adjacent teeth, devices have been devised for its measurement. In 1961, Osborn used a thin metal strip placed in the interdental space, which was moved horizontally to determine that pressure, taking into account the dynamic coefficient between the enamel and the strip [3]. Digital instruments have also been built that use strain gauges as sensors, attached to a Wheatstone bridge, whose voltage signal is amplified and filtered, and then converted into Newtons of force [3, 5, 17, 22-27]. For this, some authors used a metal strip 2 mm wide and 0.03 mm thick, dragging it with a motor, horizontally, at a constant speed of 8 m/s [3, 7]. However, other authors used 0.05 mm thick metal strips [18, 19].

The characteristics of the contact points studied by different authors are in tables 1-3.

**Table 1: Contact areas, pressures, and interdental separations, according to authors**

| Contact area [28] | Interdental pressure [28] | Interdental gap [9] |
|---|---|---|
| - upper-anterior teeth: 0.31-2.38mm$^2$<br>- upper-posterior teeth: 0.33-6.07mm$^2$<br>- inferior-anterior teeth: 0.38-2.46mm$^2$<br>- inferior-posterior teeth: 0.38-3.88mm$^2$ | - upper-anterior teeth: 0.9-23.47 gf<br>- upper-posterior teeth: 2.30-23.53 gf<br>- inferior-anterior teeth: 0.12-12.49 gf<br>- inferior-posterior teeth: 1.05-27.59 gf | - upper teeth interdental separation: 92.5 +/- 51.6 µm<br>- lower teeth interdental separation: 70.3 +/- 37.56 µm |

**Table 2: Pressure settings in interproximal dental contacts are calculated with electronic techniques, using strain gauges as sensors (in Newtons) [3]. Teeth are named according to international numbering**

| Maxilla | | Mandíbula | |
|---|---|---|---|
| **Teeth** | **Pressure (in Newtons))** | **Teeth** | **Pressure (in Newtons)** |
| 17-16 | 1,73 +/- 0,62 | 47-46 | 1,83 +/- 0,52 |
| 16-15 | 1,94 +/- 0,76 | 46-45 | 1,93 +/- 0,64 |
| 15-14 | 1,53 +/- 0,40 | 45-44 | 1,60 +/- 0,43 |
| 14-13 | 1,28 +/- 0,49 | 44-43 | 1,38 +/- 0,48 |
| 13-12 | 1,12 +/- 0,47 | 43-42 | 1,04 +/- 0,40 |
| 12-11 | 0,94 +/- 0,41 | 42-41 | 0,91 +/- 0,28 |
| 11-21 | 0,88 +/- 0,37 | 41-31 | 0,87 +/- 0,20 |
| 21-22 | 1,01 +/- 0,48 | 31-32 | 0,89 +/- 0,20 |
| 22-23 | 1,09 +/- 0,41 | 32-33 | 0,92 +/- 0,18 |
| 23-24 | 1,36 +/- 0,49 | 33-34 | 1,18 +/- 0,42 |
| 24-25 | 1,49 +/- 0,75 | 34-35 | 1,43 +/- 0,45 |
| 25-26 | 1,73 +/- 0,71 | 35-36 | 1,85 +/- 0,63 |
| 26-27 | 1,65 +/- 0,53 | 36-37 | 1,99 +/- 0,68 |

**Table 3: Different characteristics of interproximal contact points, according to authors**

i. Interproximal contact pressures are lower in the maxilla than in the mandible [6, 18], although for other authors they are similar [17].
ii. In the mandible, the lowest pressure was between the canine and the first premolar and the highest was between the second premolar and the first molar [6, 18].
iii. The bite increases the interproximal pressure in the maxilla, but it does not change in the mandible [6,18], although for other authors it was not significant [17].
iv. This pressure increases from morning to noon and decreases in the afternoon [6, 7, 18].

v. There is a decrease in pressure in posterior interproximal contacts in the maxilla and mandible in the supine position and these pressures increase again if the orthostatic position is returned [7].
vi. There is a continuous decrease in the fit of the contact points in the posteroanterior direction [17].
vii. The adjustment of mandibular contact points is higher in men than in women [3,17].
viii. When the lengths of the maxillary or mandibular arch are excessive, there is a decrease in contact adjustments. If they are default, there are greater contact adjustments [17].
ix. Contact points are greater distally than mesially in both arches [17].
x. Occlusal dental contacts influence the fit of dental interproximal contacts during bite [29, 30].

This study aimed to standardize a simple and easy-to-use method for the clinician to determine the fit of interproximal contact points, using a dynamometer.

## MATERIAL AND METHODS

### a. Measuring Instrument

A 6 mm wide and 0.03 mm thick steel strip (Polydentia) was used, attached to a Tofflemire matrix holder, and this in turn attached to a dynamometer (figure 1).

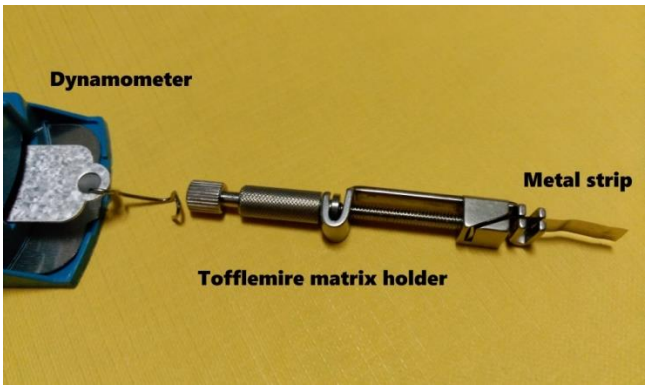


**Figure 1: Metal strip connected to the dynamometer through the Tofflemire matrix holder**

### b. Calculation of the Coefficient of Friction between Wet Enamel and Steel

It was done before this work, according to general descriptions of the calculation [31,32]. We take an inclined plane of steel metal on which the enamel of a wet tooth slides. The plane is tilted until the tooth begins to move. The coefficient of friction is tangent to the angle of inclination. We take the value obtained as $\mu = 0.176$.

## METHODOLOGY

The dynamic force of friction ($F_d$) is defined as the normal force N multiplied by the coefficient of friction ($\mu$) [11]:

$F_d = N \times \mu$

Figure 2 explains the calculation performed to determine the interproximal contact pressure between two adjacent teeth.

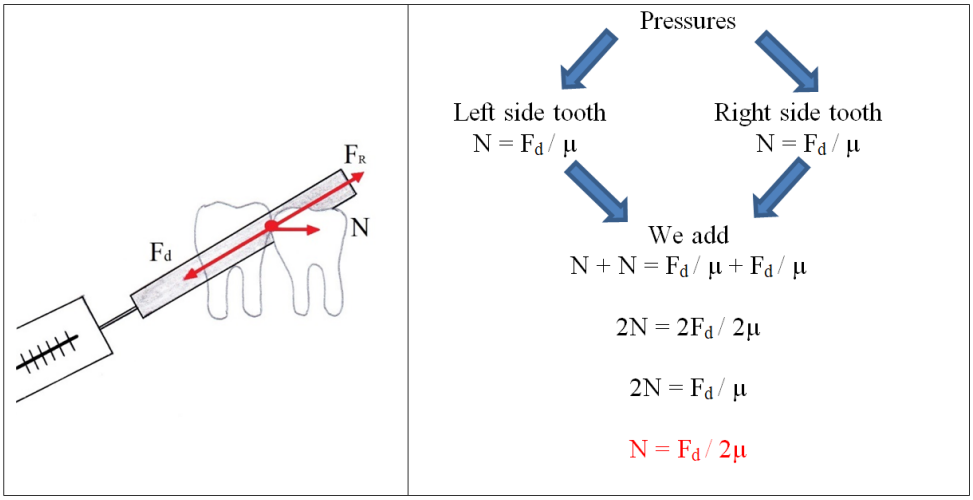


**Figure 2: Calculation to determine the interproximal contact pressures**

To obtain the value N we need to know:

- **$F_d$:** value obtained on the dynamometer by dragging the metal strip.
- **μ:** coefficient of friction wet enamel - steel metal. It is 0.176, as we have previously calculated.

The metal strip is inserted at the interproximal point and then dragged horizontally by pulling with the dynamometer. The force has the highest value at the moment the strip is displaced and is considered the interproximal contact fit. It is convenient to repeat up to three times in each contact area, taking the mean of these three measurements as a representative value. The opening of the mouth affects the points of contact, due to the activation of the lower bundle of the lateral pterygoid muscle. For this reason, following previous authors [7], the opening of the mouth must be limited to 20 mm so that this muscle is as relaxed as possible. This is achieved by dragging the strip in a horizontal direction.

## RESULTS

The formula used to calculate the adjustment of a contact point (N) is:

$N = F_d / 2\mu$

The coefficient of friction (μ) previously calculated is 0.176. Thus, the formula to be used is:

$N = F_d / 2 \times 0.176$ ; $N = F_d / 0.352$

The dynamic friction force ($F_d$) is given by the dynamometer when dragging the strip horizontally between the teeth. Once we have $F_d$, we use the expression $N = F_d / 0.352$ to obtain N.

## DISCUSSION

Numerous authors have highlighted the importance of maintaining good contact points to avoid interdental problems [1-8], as well as to make correct restorations [1, 2, 4, 14, 19, 20]. However, its evaluation of the use of dental floss is quite subjective [1, 3, 5-8].

Until now, most devices used to assess pressure at these contact points are too complicated for daily clinical use, which demands simplicity and speed. Digital instruments (strain gauges such as sensors, transducers, amplifiers, and display screens) have been used by various authors experimentally [3, 5, 7, 17, 22-27], but they are also complicated for daily clinical use. For this reason, in this work, we describe the use of the dynamometer, with a simpler technique.

Although some authors use 0.05-mm-thick metal strips [18, 19], we have preferred 6-mm-wide and 0.03-mm-thick ones, as they are easy to acquire on the market and easy to handle. The measurement with the dynamometer is simple and gives a direct measurement in Newtons, while other electronic experimental instruments [3] have to transform the output voltage into units of pressure. The Tofflemire matrix holder has been used in the past for in vitro investigation of contact points [4], and it is an element that is usually present in all dental clinics, just like metal strips. In most cases, the clinician acts on the adjustment of the contact points by passing a diamond strip, in an improvised way and without knowing the ideal pressures of that area [6].

It is known that the coefficient of friction depends on the presence or not of water. In general, water increases the adhesion of surfaces and increases the friction force, although on other occasions it is described as a lubricant [22]. Some authors point out saliva as a lubricant, reducing the coefficient of friction [10, 33]. In experimental studies, artificial saliva has been used [13, 34], but we recommend the patient's natural saliva as lubrication.

## CONCLUSION

A simple way to determine the fit of the interproximal contact points N in the clinic can be with the use of a 6 mm wide and 0.03 mm thick metal strip, attached to a dynamometer through a Tofflemire matrix holder. The formula we use is $N = F_d / 0.352$. The dynamic force $F_d$ is given by the dynamometer when the strip begins to move between the two adjacent teeth. This makes it possible to improve dental restorations at those points.

## ACKNOWLEDGMENT

Years ago, Professor Dr. Ambrosio Bermejo Fenoll suggested that I study interproximal pressures in teeth. We evaluated without result the use of electronic techniques, using strain gauges as sensors. Then, we used dynamometers. However, those studies remained unfinished. Later, he devoted his time to studying speech development in chimpanzees and Neanderthals, while I turned my attention to establishing and developing the concept of hyperbolic medicine. On December 22, 2022, the professor passed away. For this reason, these days I have resumed those first studies of interproximal pressures to finish this work. It is a memory and posthumous gratitude.

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