



UNIVERSIDADE FEDERAL DE UBERLÂNDIA
FACULDADE DE ODONTOLOGIA



PAULO CÉSAR BANDEIRA JUNQUEIRA

**ISOLAMENTO ABSOLUTO: ASPECTOS BIOMECÂNICOS E CARACTERÍSTICAS
FÍSICAS DE LENÇÓIS DE BORRACHA**

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Trabalho de conclusão de curso apresentado à Faculdade de Odontologia da Universidade Federal de Uberlândia, como requisito parcial para obtenção do título de Graduado em Odontologia.

Orientador: Prof. Dr. Carlos José Soares

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Trabalho de Conclusão de Curso aprovado
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RESUMO

Esse estudo tem como objetivo avaliar o desempenho biomecânico por meio da resistência máxima à tração (UTS, MPa), Força de Ruptura (RF, N) e alongação (%) de 21 lençóis no mercado para isolamento absoluto. Vinte e um lençóis de borracha foram testados: All Prime; Madeitex; Sanctuary Black, Green, Blue, Non látex; Nictone Blue, Black; Mk life; Elastidam; Bassi; Pribanic; Care; OK; MDC dental; Keystone; Dura Dam; Flexi dam; Sanctuary Blue; Nictone Blue; Ehros; USE. As amostras (n=15) foram cortadas seguindo o padrão ISO 9001 (medidas de 80 × 10 mm, com um furo de 1,74 mm no centro). Foram testadas com uma máquina de ensaios universal (EMIC) com célula de carga de 500 N e carga de tração a uma velocidade de 500 mm/min até a ruptura. Foram realizadas análises de MEV, EDS, espessura e radiopacidade. Dados foram analisados por ANOVA de um fator e teste de Tukey ($\alpha = 0,05$). Nictone teve a maior espessura (0,4 mm folha grossa e 0,3 mm média) e o maior valor de RF (35,5 N). Os demais produtos apresentaram valores de UTS variando entre 19N - 30 N. O lençol Bassi apresentou maiores valores de UTS. Observou-se defeitos estruturais que podem comprometer a contaminação do campo operatório em alguns produtos testados. Os elementos predominantes foram C, Mg, S, Si e Ca. As propriedades mecânicas variaram substancialmente, expressando a falta de padronização dos lençóis encontrados no mercado. A maioria dos diques de borracha apresenta propriedades mecânicas e físicas adequadas para o uso clínico. O maior custo de mercado não reflete em melhor desempenho biomecânico dos lençóis de borracha.

Palavras-chave: Lençol de borracha; custo; testes mecânicos; propriedades mecânicas.

ABSTRACT

Objective: This study aims to evaluate the mechanical and physical properties of dental dam sheets used for absolute isolation and to correlate the mechanical parameters with cost.

Methods and materials: Twenty-one dental dam sheets were tested: All Prime; Madeitex; Sanctuary non-latex, Sanctuary latex black, green, and blue; Nic Tone blue and black; Mk Life; Elastidam; Bassi; Pribanic; Care; OK; MDC Dental; Keystone; Dura Dam; Flexidam; Sanctuary blue; Nic Tone blue; Ehros; and USE. The thicknesses of the dental dam sheets were measured using a digital micrometer (Mitutoyo). Dental dam sheets ($n = 15$) were prepared by cutting the samples following the ISO 9001 standard, with dimensions of 80 mm $\times$ 10 mm and a 1.7 mm hole made at the center of each specimen. The specimens were tested using a universal testing machine (Emic) at a speed of 500 mm/min until rupture to calculate their thickness (mm), rupture force (RF, N), elongation (%), and ultimate tensile strength (UTS, MPa) scanning electron microscopy and X-ray energy dispersive spectroscopy analyses were performed. The radiopacity was measured using digital radiography. Thickness, UTS, RF, and elongation data were analyzed by one-way ANOVA and Tukey's test ($\alpha = 0.05$).

Results: Flexidam dental dam had the thickest (0.5 mm), while Nic Tone had a medium thickness of 0.3 mm; the RF value (41.3 N) was also higher for thick dental dams. The other samples had RF values ranging from 19 to 30 N. The highest elongation was obtained for the non-latex Sanctuary dental dam (600 mm). The Bassi dental dam had the highest UTS value (15 MPa), and medium and small particles were observed in most of the gums. A loss of continuity was detected in the structure of Sanctuary green and blue media. The predominant elements in the sheets were carbon, magnesium, sulfur, silicon, and calcium.

Conclusions: The mechanical properties demonstrated by the UTS, RF, and elongation varied substantially, indicating a lack of standardization of dental dam sheets. Most of the dental dams studied have mechanical and physical properties suitable for clinical use. The correlation coefficient between the cost and mechanical properties was very low.

Clinical significance: The dental dams analyzed presented mechanical properties and physical characteristics suitable for clinical use. However, a higher dental dam cost does not result in improved mechanical properties.

Key words: dental dam; rubber dam; absolute isolation; cost; mechanical tests; mechanical properties.

Biomechanical and physical characteristics of rubber dam sheets used for absolute isolation – cost effective correlation.

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Running title: mechanical performance of rubber dam sheets

CONFLICT OF INTEREST

The authors confirm that they have no conflict of interest.

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3.1 Introduction

Dental dam isolation has been considered the gold standard of protection during restorative and endodontic procedures for the last 150 years.^{1,2} The dental dam barrier has multiple benefits such as moisture control as well as prevention of contamination with saliva and blood.³ Dental dams also reduce the risk of cross-infection and aerosol contamination, allowing an aseptic area, workflow improvement, and promotion of patient satisfaction and stress reduction.⁴ During the COVID-19 pandemic, the protection provided by absolute isolation was considered an essential tool for correct operative practice due to its protection against oral fluids, with a significant reduction in the presence of particles in the aerosol by up to 70%.^{5,6}

The effect of absolute isolation on improving the performance of adhesive procedures is controversial.^{7,8} The use of dental dams to avoid the presence of high humidity during restorative procedures can generate significant benefits, such as the reduction of cusp deformation, reduction of shrinkage stress, and improvement of bond strength in composite resin restorations.⁹ An additional beneficial effect on the bond strength to enamel has been observed, supporting its systematic application.¹⁰ On the other hand, other studies demonstrated no significant benefit on the clinical performance of direct composite restorations when using different isolation strategies, either absolute or relative.¹¹

The dental dam sheet is generally composed of natural latex, also known as caoutchouc, which is a coagulated or precipitated substance made from the latex of rubber plants (*Hevea brasiliensis*).¹² This component forms non-linked but partially vulcanizable polymer chains with molecular masses of approximately 10^6 Da and elastic properties.¹³ The rubber molecules of latex have a specific organization, and these rubber particles are described as pear-shaped structures with a polymer core surrounded by a thin shell consisting of phospholipids and proteins mixed together.¹⁴

Natural latex is an elastomer applicable in many industries, such as gloves, balloons, dental dams, and other medical products.¹⁵

Exposure to allergenic proteins present in natural latex can trigger an exaggerated immune response in sensitized individuals, resulting in allergic symptoms ranging from urticarial and itching to anaphylaxis.^{16,17} Hundreds of allergens have been identified in natural latex, of which 15 (Hev b1 to b15) have been officially listed as potential allergens by the World Health Organization (WHO).¹⁸ Some additives used in the manufacturing of latex products, such as vulcanization catalysts and antioxidants, may also play a role in latex allergies.¹⁹ Therefore, latex-free dental dams, produced with polyisoprene-based material have been developed with a similar polymer structure as natural rubber without the potential allergen of latex protein.^{20,21}

Dental dams are sheets of natural or synthetic latex, generally available in three different thicknesses (thin, medium, and thick) and two sizes (15" x 15" and 16" x 16") in different colors. Several ingredients are added during rubber industrialization, such as accelerators, antioxidants, wax, and deodorant, as well as some elements such as zinc, sulfur, and calcium.²² The presence of these components can influence the mechanical behavior of the dental dam.²³ Although specific manufacturing standards exist for dental dam sheets used in dentistry (A-A-53986 Rubber Dam Dental 36s ANSI; ISO 16635-1/2013 AND ISO 16635-2/2014), a significant lack of standardization exists among companies. The lack of standardization can also compromise the clinical performance of dental dam isolation.²⁴ Consequently, clinicians may be reluctant to use dental dams, causing most restorative procedures in the clinic to be performed without absolute isolation.²⁵

The damage caused by microtears during the perforation of a dam sheet is related to the quality of the punching and dental dam sheet as well as the perforation technique. This tearing problem is more common during the passing of the dental into the interproximal area, which is associated with high friction combined with the elongation properties.²⁶ Analyzing the mechanical and physical properties of dental dam sheets is important to understand their behavior and improve their performance. Meanwhile, substantial variation in the cost of dental dams has been observed. To the best of our knowledge, no study has related market cost to the different mechanical and physical parameters used to characterize different dental dams. The

correlation between the cost and mechanical parameters of dental dams is important for clinicians.

Therefore, this study aims to evaluate the biomechanical performance expressed by the ultimate tensile strength (UTS, MPa), rupture force (RF, N), and elongation (%) of 21 dental dam sheets available for absolute isolation. The null hypotheses were as follows: 1) the dental dam sheet type would not influence the mechanical performance and 2) the mechanical properties of the dental dam sheet would not correlate with the cost.

3.2 Material and method

Twenty-one dental dam brands were tested (Table 1). The specimens (n = 15) were prepared by cutting the dental dam sheet using a specially manufactured knife cutting machine (SOMEH, Joinville, Brazil; Figure 1A) in a rectangular format following the ISO 9001 standard with dimensions of 80 mm × 10 mm (Figure 1B). A 1.7 mm hole was also made in the center of each specimen (Figure 1C) using a dental dam perforator (Golgran, São Caetano do Sul, São Paulo, Brazil, Figure 1D). The specimens were tested without aging. The thicknesses (mm) of the dental dam sheets were measured using a digital micrometer (Mitutoyo, Tokyo, Japan) with a precision of 0.001 mm (Figure 1E) at four points before and after the mechanical tensile test. The length and width of each specimen were measured using a digital caliper (Mitutoyo, Tokyo, Japan; Figure 1F).

The RF (N), elongation (mm), and UTS (MPa) were calculated by performing a tensile test with a mechanical testing machine (DL 3000 EMIC, São José dos Pinhais, Paraná, Brazil) using a load cell of 500 N at a cross-head speed of 500 mm/min until rupture. Two marks were placed on the specimen, 20 mm from the top and bottom edges, to create a reference where each gripper held the specimen (Figure 2). The percentage of elongation was determined using the ASTM D412 method. The initial length of the specimen was measured. After rupture, the percentage elongation was calculated using the following formula: $E = 100 (L - L_0) / L_0$, where L = final length and L_0 = initial length. The UTS was calculated using the formula: $\sigma_{max} = F_{max} / A_0$, where F_{max} = maximum force and A_0 = original cross-sectional area.

The dental dam was analyzed using scanning electron microscopy (SEM) and X-ray energy dispersive spectroscopy (EDS). A 2 mm-diameter specimen was fixed on a metal stub and coated with a thin layer of gold (QR 150ES; Quorum). SEM was performed using a VEGA 3 LMU instrument (Tescan) at different magnifications (100x; 500x, and 5000x). The elemental distribution and composition were analyzed using EDS (Oxford Instruments, England). The regions of interest were magnified 1,000x to identify the chemical elements in the dental dam. Mapping was also performed to visualize the spatial distribution of the elements on the surface of the dental dam sheets and obtain information regarding the composition, homogeneity, and presence of possible impurities or filler materials in the dental dam.

For radiopacity analysis, a 5.0 mm x 5.0 mm dental dam square of each material was placed on a phosphor plate (Durr Dental, Bietigheim-Bissingen, Germany) next to an aluminum stepped wedge (Odeme, Lucerna, Brazil). Radiographic exposure was performed using a Timex 70 E instrument (Gnatus, Ribeirão Preto, Brazil) with an exposure time of 0.28 s at 70 kV and 7.0 mA. The phosphor plate was placed 20 cm away from the radiographic cylinder. The radiographs were transferred from the phosphor plate to a computer using a digital scanner (VistaScan, Dürr Dental, Bietigheim-Bissingen, Germany). Radiopacity was determined using the resident software provided by the manufacturer (DBSWIN, Dürr Dental).

Data were first analyzed for a normal distribution (Shapiro-Wilk test) and homoscedasticity (Levene's test). Analysis of variance, followed by Tukey's post-hoc multiple comparison test, was used to compare the mechanical and physical parameters of the dental dams. The Pearson correlation test was used to verify whether correlation existed between the RF, UTS, elongation tip, and market cost of the dental dams. All tests used a significance level of $\alpha = 0.05$, and all analyses were carried out with the statistical package Sigma Plot version 13.1 (Systat Software Inc., San Jose, CA, USA).

3.3 Results

The mean and standard deviation thickness values (mm) of the tested dental dams are shown in Figure 3. One-way ANOVA showed significant differences in the thickness among the tested dental dams ($P < 0.001$). All dental dam thicknesses

were in the range of 0.2 mm to 0.5 mm. Flexidam had the greatest thickness (0.5 mm), whereas CARE had the smallest thickness (0.17 mm).

The means and standard deviations of dental dam rupture force values (N) are shown in Figure 4. One-way ANOVA revealed significant rupture force differences among the tested dental dams ($P < 0.01$). Sanctuary black had the lowest rupture force (11.7 N), while Nic Tone had the highest RF (35.5 N).

The means and standard deviations of dental dam elongation values (mm) are shown in Figure 5. One-way ANOVA showed significant differences among the tested dental dams ($P < 0.01$). The polyisoprene Sanctuary dental dam had the highest elongation value (591 mm), while the Sanctuary black dental dam had the lowest elongation value (276.4 mm).

The means and standard deviations of the dental dam UTS values are shown in Figure 6. One-way ANOVA showed significant differences among the tested dental dams ($P < 0.01$). The Bassi dental dam had the highest UTS (14 MPa), while the Sanctuary black medium had the lowest (5 MPa).

SEM

SEM images of the dental dam surfaces were used to analyze the particle morphology and composition (Figure 7). Different particle sizes were detected and distributed across the dental dams. Small- and medium-sized particles were prevalent (Figure 8A). The Sanctuary black dental dam contained the largest particles (Figure 8B). Irrespective of thickness and color, Nic Tone dental dams had a higher concentration of small particles than the other dental dams (Figure 8C). These small particles appeared to aggregate to form larger clusters. Finally, the CARE, All Prime, Ehros, and Sanctuary dental dams of medium thickness in blue and green colors showed discontinuities on their surface (depressions) resembling micro-perforations; deep lines were observed in the thick Nic Tone gum (Figure 9).

The EDS chemical composition analysis of the dental dams is shown in Intense peaks of carbon (72% to 19%) and oxygen (35% to 5%) were observed in the dental dams, indicating the prevalence of these elements. Traces of magnesium (11% to 0%), silica (15% to 0%), sulfur (5.4% to 0%), zinc (2.9% to 0%), titanium (2.2% to 0%), and calcium (8.4% to 0%) were also found. The Nic Tone dental dam sheets showed more intense calcium peaks (34% and 21%).

The radiopacity of the dental dam was very low and similar for all tested dental dams, which was almost unperceivable in the X-ray images (Figure 10).

Negative correlation was observed between the cost and UTS (MPa) ($r = -0.537$) (Figure 11A). Meanwhile, weak correlation was found between the cost and rupture force (N) ($r = 0.022$) (Figure 11B).

3.4 Discussion

The mechanical performance of the studied dental dams varied significantly. Therefore, the first null hypothesis was rejected. The dental dam sheets exhibited different structural characteristics and mechanical performance. The mechanical behavior of a dental dam is determined by the nature of the material and its fabrication. In this study, thicker dental dam sheets did not have higher mechanical performance (UTS and elongation).²⁴ When the dental dam was subjected to a UTS test, stress was generated at the center of the specimen, and thicker dental dam with greater mass dispersed less stress, thus decreasing the rapid propagation of cracks.²⁷

The manufacturer classified Flexidam non-latex dental dam as a medium-thickness sheet; however, this product exhibited the highest thickness (0.5 mm). This thickness was higher than dental dams listed as "thick" dams, such as Nic Tone thick (0.40 mm) and Sanctuary thick (0.25 mm). This information confirmed the lack of standardization of various commercial brands,²⁴ which could lead to confusion for clinicians during the use of dental dams in absolute isolation. Quality standards and controls in the manufacturing process are paramount for dental dam sheets to meet the necessary requirements, and regulations should be improved to minimize this misinformation.

The RF was not influenced by the dam thickness. A notable example is the Flexidam non-latex dental dam, which, despite having the greatest thickness, required less than half the RF to break (11 N) compared to other dams, such as the thick and medium Nic Tone blue, which were thinner and exhibited higher RF values (40 N and 38 N, respectively). Factors such as material composition, latex or synthetic polyisoprene, particle size, distribution, and composition,²⁸ molecular structure, interaction strength, cross-linking density,^{29,30} and vulcanization process of these materials can influence the dental dam mechanical parameters.³¹

There are also clinical aspects that could influence the mechanical behavior of the dental dam, such as the operator's knowledge and skills,^{32,33} and the complexity

of the case.³⁴ The use of lubrication of the dental dam using a water-soluble lubricant before positioning can facilitate this procedure.³⁵ The use of clamp position, such as the parachute technique,³⁶ or the winged technique, could be very helpful in reducing the risk of tearing when placing the dam. Regarding how the particle distribution, expressed by the size range, influences the RF, two scenarios were observed in this study: first, a narrow particle distribution, that is, the particle size follows a pattern of small particles over the entire length of the dam sheet, was observed (Figure 8C). Second, a broad particle distribution with different particle sizes was observed (Figure 8B). The explanation for the higher RF of the Nic Tone blue latex dental dams is probably related to their narrow particle size distribution. This distribution allows the particles to interact uniformly with each other so there is a better transmission of forces, resulting in a higher capacity for plastic deformation.^{28,37}

Sanctuary is a polyisoprene material, whereas Coltene only states that it is a non-latex elastomer without specifying its nature and composition. However, considering this limitation, we can infer that the highly elastic behavior of the studied non-latex dams could be due to the linear molecular structure of synthetic polyisoprene. These linear chains can slide more easily between them, providing an elastic behavior, which provides greater elongation.³⁸ For latex dams, variables such as additional components in their composition, including pigments, vulcanizing agents, and the presence of cross-links, could limit the mobility of the rubber chains, thus reducing their elongation capacity.³⁹

The flexibility of a dental dam plays an important role during the clinical setting.³³ The ability to be pulled without requiring so much effort is very important and useful when necessary to reach more posterior teeth or the cavities with very sharp angels without tearing the dental dams. However, it could be a disadvantage when the soft tissue retraction is required.³⁶ Bassi latex dam, which was found to have intermediate thickness and elongation but the highest breaking strength, exhibited a higher UTS. Bassi dam had a smaller cross-sectional area, and the high strength value led to a higher UTS when compared to dams that were thicker. Dental dams that reached higher UTS values could be inferred to have a higher number of cross-links, resulting in a denser and stronger three-dimensional network structure.³⁸ This UTS is a fundamental characteristic during the absolute isolation maneuver.³⁶ On the other hand, the Flexidam dam presented the lowest UTS. This could be associated with the nature of the material, as it is described by the manufacturer as a

material with very low tension, which could be beneficial during isolation maneuvers where minimum tension is required in the dental dam clamp complex.

Tear strength and flexibility are two key properties that are often weighted in the selection of dental dams. High tear strength is desirable because it ensures the durability of the dam during long procedures and reduces the risk of breakage. Dams with high tear strength are less likely to fail under stress, providing an effective and durable barrier throughout the entire procedure.³⁶

Therefore, while high tear strength is a desirable characteristic of dental dams, flexibility also plays a crucial role in certain clinical situations. A balance between these properties, based on a careful assessment of the needs of the procedure and the patient, can lead to better clinical outcomes and greater efficiency in the management of dental isolation.

Another important property is the degree of vulcanization, which is a key factor affecting the properties and mechanical performance of dams.³⁹ In this process, sulfur compounds or other vulcanizing agents are added to the latex mixture, which will shape its final behavior. Therefore, an adequate degree of vulcanization is essential for the correct manufacturing of a dental dam. In this study, the black dams exhibited significant differences in breaking strength, elongation, and UTS. One explanation for this finding is that these dams contain carbon black as a pigment, which is associated with the restriction of cross-link mobility caused by the stiffness of the pigment. This restriction reduces the ability of the material to deform and stretch, which is reflected in lower mechanical properties such as elongation and UTS.⁴⁰ However, higher stiffness may offer greater resistance to deformation when subjected to loads or forces, which can be beneficial in certain applications during insulation. For example, in applications where higher fabric shrinkage is required and excessive deformation of the sheet must be avoided, a higher-stiffness dental dam may be preferable.

A tendency for the UTS to decrease as the cost increased was observed (Figure 11A). However, this did not follow a linear correlation and could be influenced by several factors, such as the material quality, manufacturing process, and chemical composition.²⁸ A correlation coefficient of $r = 0.02$ was found between the cost and the RF of the dental dam (Figure 11B). Understanding the relationship between the cost of a dental dam and its mechanical properties is crucial in the decision-making process of dental professionals. A common perception is that high-cost dental dams

inherently offer superior mechanical properties. However, this correlation is not always straightforward or absolute. This study reveals that despite variations in the cost of the analyzed dental dams, mechanical properties such as the UTS, RF, and elongation exhibit significant variability across different brands.

There are still many clinicians who are swayed by the marketing and price of materials, without adequately considering the actual performance of the product.^{41,42} By demonstrating that a product with a low value can offer proper mechanical properties and perform optimally in clinical applications, we seek to provide practical guidance for more informed and evidence-based decision making. This relationship underscores that cost is not always indicative of quality and that more affordable materials can meet clinical expectations, thereby promoting better product selection based on their technical and clinical merits.

This inconsistency underscores the lack of standardization in dental dams and suggests that price does not reliably indicate the quality of the mechanical properties. Therefore, dental professionals should meticulously consider not only financial cost but also the specific mechanical properties necessary to ensure optimal performance in clinical situations. This approach allows well-informed decisions that strike a balance between effectiveness and economic efficiency.

3.5 Conclusion

With the limitations of the study design, the follow conclusions can be drawn:

- Most dental dam sheets have mechanical and physical properties suitable for clinical use.
- The dental dam type influenced the mechanical performance.
- Dental dams that exhibited smaller-sized particles showed better mechanical performance.
- Black-colored dental dams exhibited lower mechanical properties.
- No significant correlation was found between the cost and biomechanical performance of the dental dam sheets.
- A noticeable lack of standardization in dental dam manufacturing can potentially complicate product selection by clinicians.

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APÊNDICE A – FIGURAS

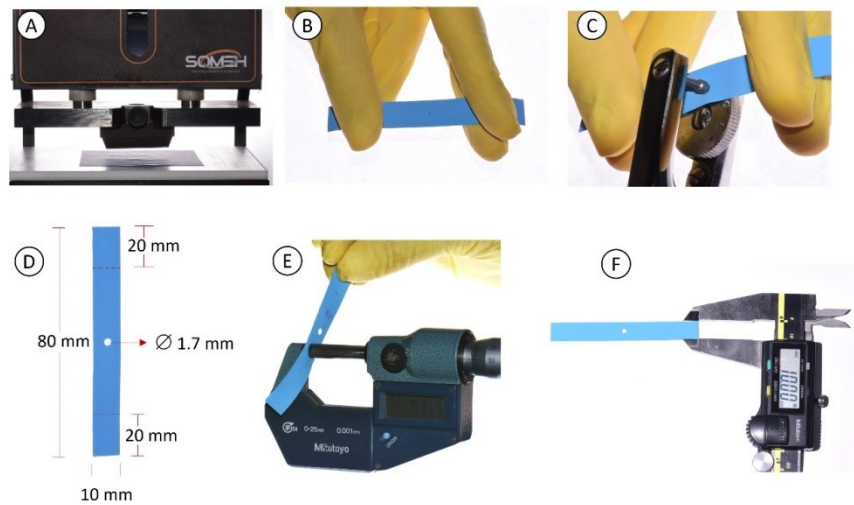


Figure 1. A. Cutting machine and dental dam sheet; B. Specimen cut of dental dam; C. Centralized hole with punching clamp; D. Aspect of specimens obtained for dental dam sheet; E. Measurement of the dental dam thickness; F. Final aspect of specimen measured using digital caliper.



Figure 2. A. Specimen positioned on the clamp before testing. B. Specimen after rupture.

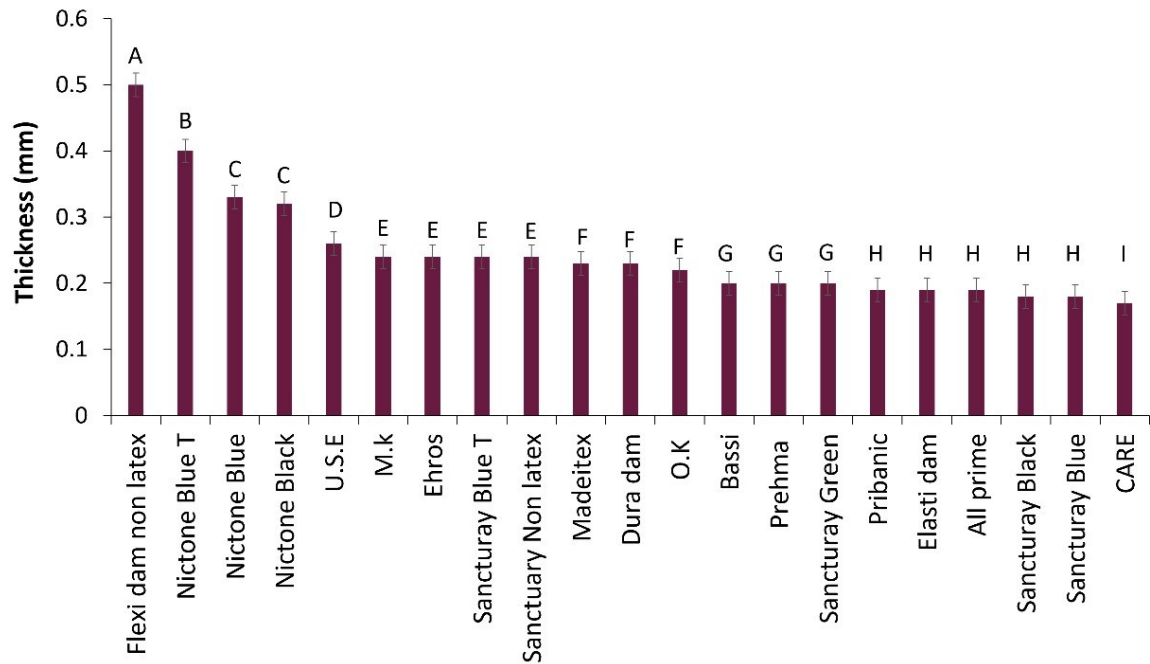


Figure 3. Mean and standard deviation of the tested dental dam thickness values (mm). Different capital letters mean significant difference obtained by Tukey test ($p < 0.05$).

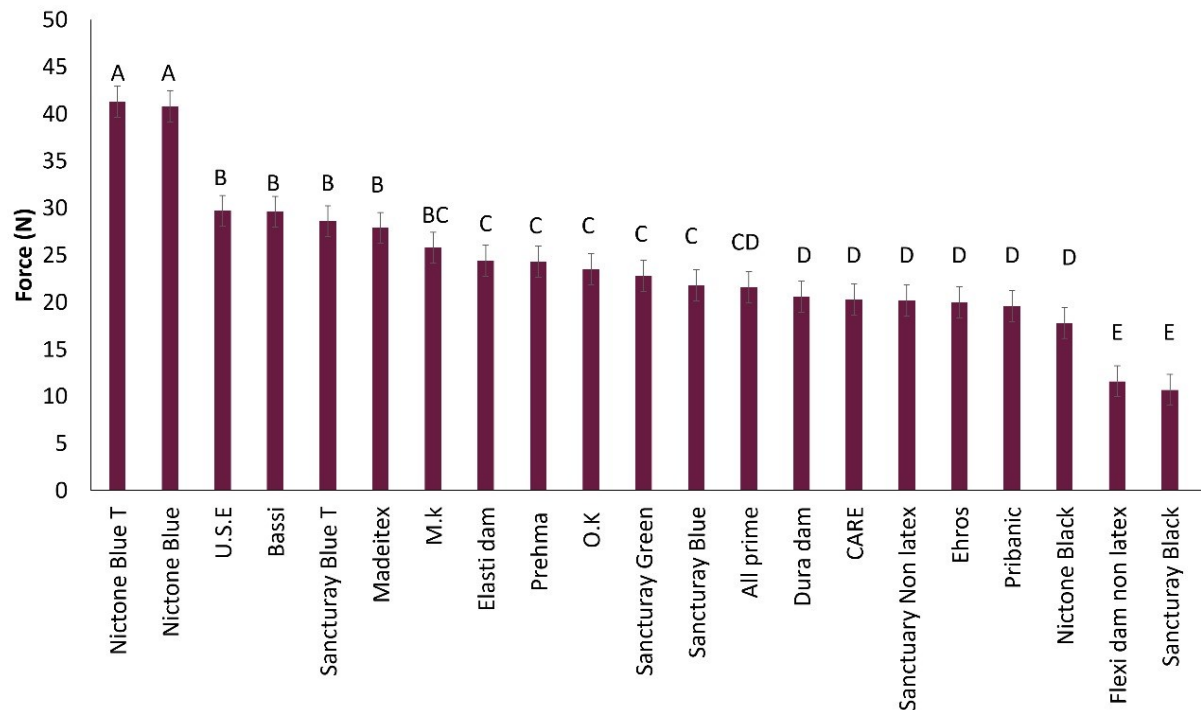


Figure 4. Means and standard deviations of rupture values (N) for of the tested dental dams. Different capital letters mean significant difference obtained by Tukey test ($p < 0.05$).

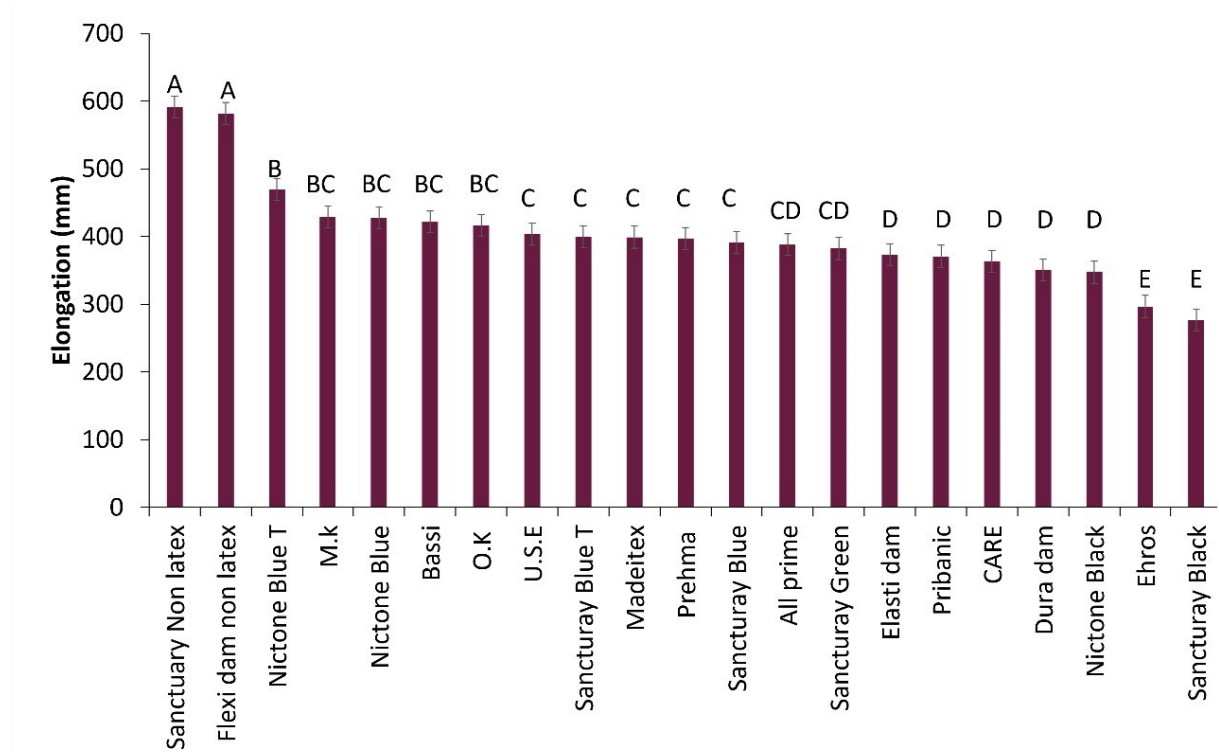


Figure 5. Means and standard deviations of dental dam elongation values (mm). Different capital letters mean significant difference obtained by Tukey test ($p < 0.05$).

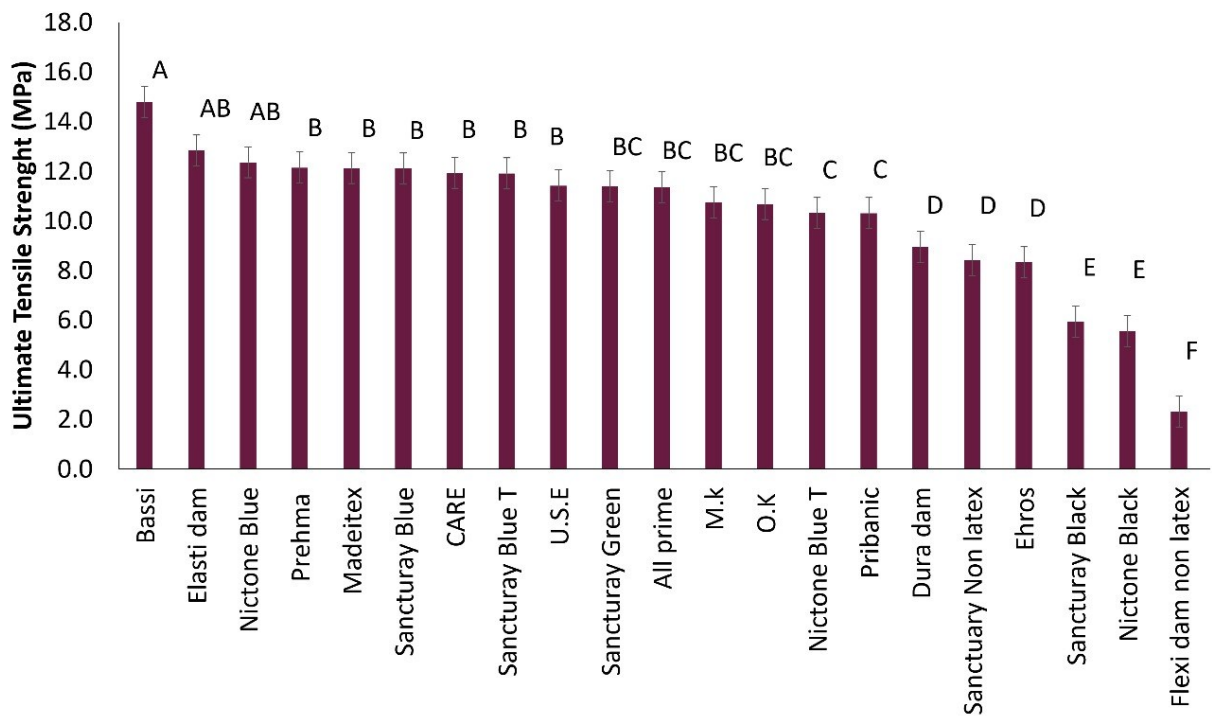


Figure 6. Means and standard deviations of the dental dam ultimate tensile strength values (MPa). Different capital letters mean significant difference obtained by Tukey test ($p < 0.05$).

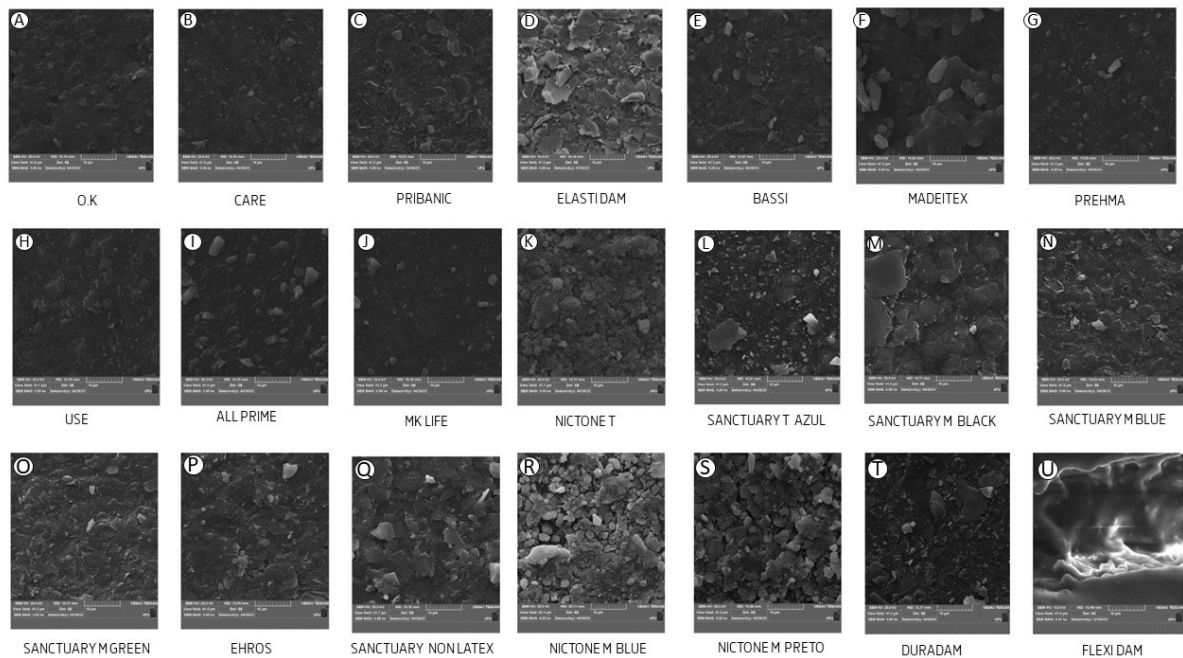


Figure 7. SEM images of the dental dam surfaces. A. OK. B. Care. C. Pribanic. D. Elastidam. E. Bassi. F. Madeitex. G. Prehma. H. USE. I. All prime. J. MK Life. K. Nictone Thick Blue. L. Sanctuary thick blue. M. Sanctuary Medium black. N. Sanctuary Medium blue. O. Sanctuary medium green. P. Ehros. Q. Sanctuary non-latex. R. Nictone Medium blue. S. Nictone Medium black. T. Duradam. U. Flexidam.

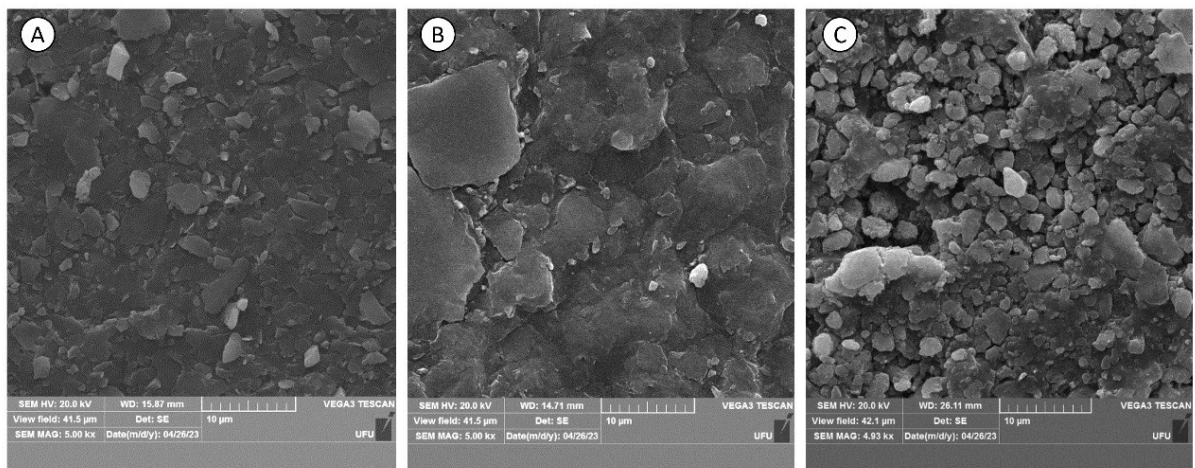


Figure 8. Different particle sizes. A. Small- and medium-sized particles. B. Larger particle sizes. C. Small particles sizes.

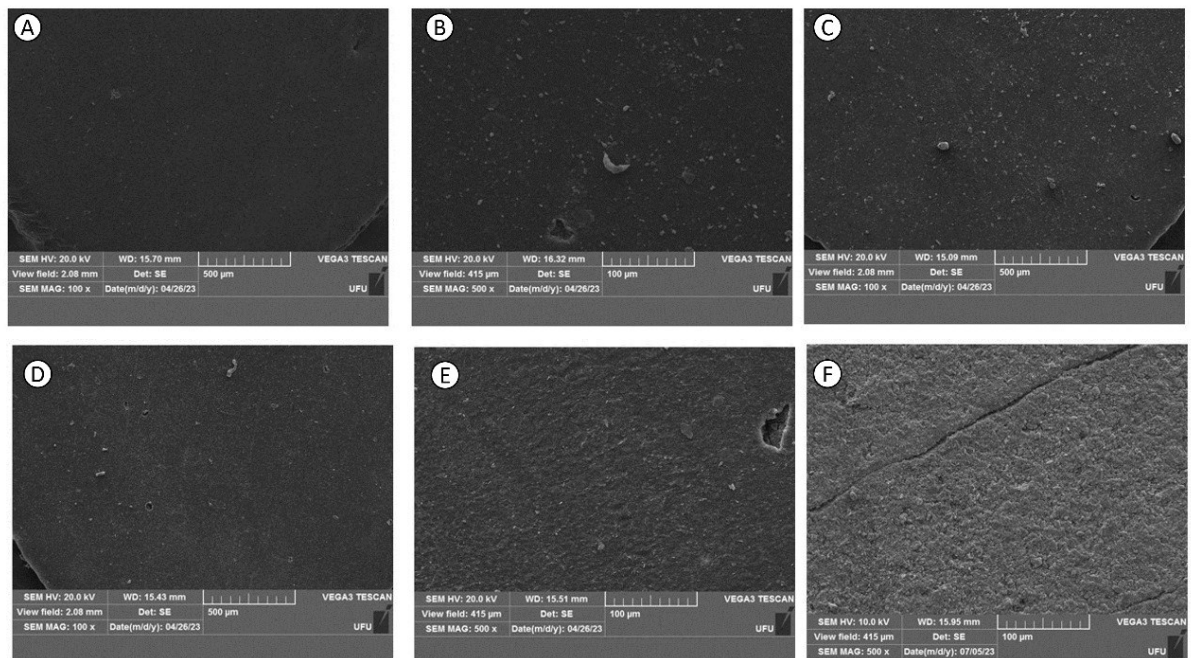


Figure 9. Damages observed on the new dental dams. A. Care. B. All prime. C. Ehros. D. Sanctuary green. E. Sanctuary blue. F. Nictone thick blue

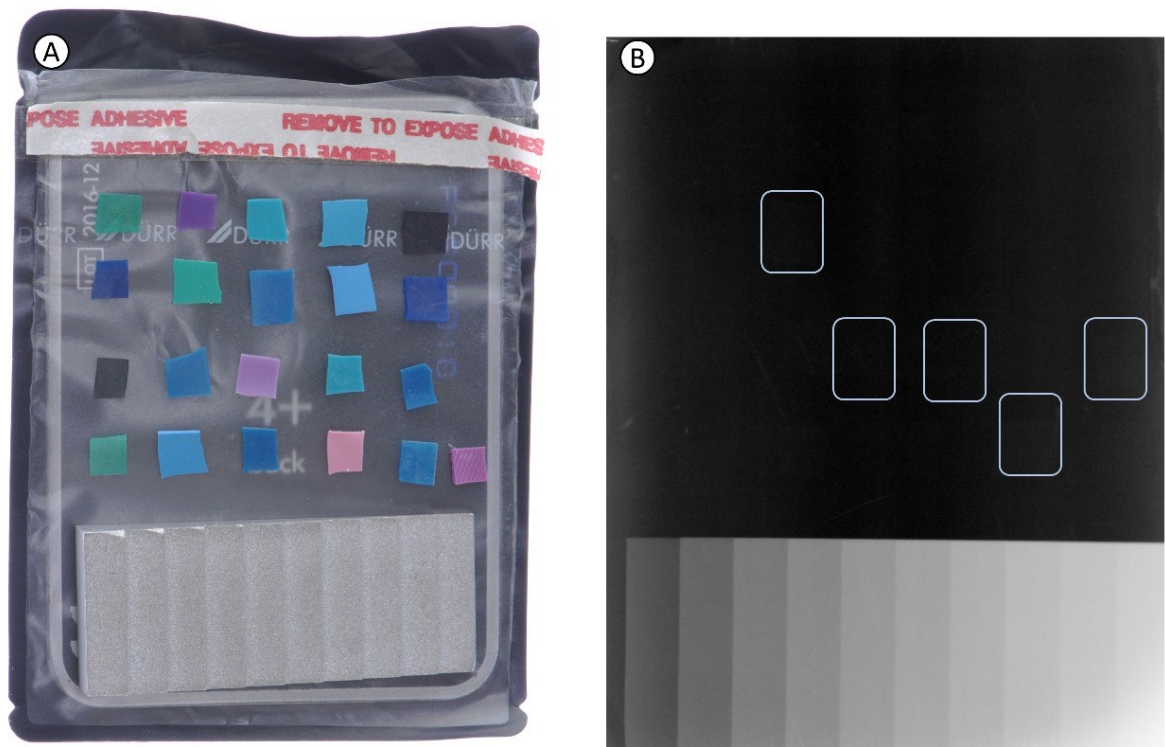


Figure 10. The radiopacity of the rubber dam. A. Image of the specimens of each rubber dam next to lead scale on the Xr digital plate. B. The very low or absence of the radiopacity of the dental dam.

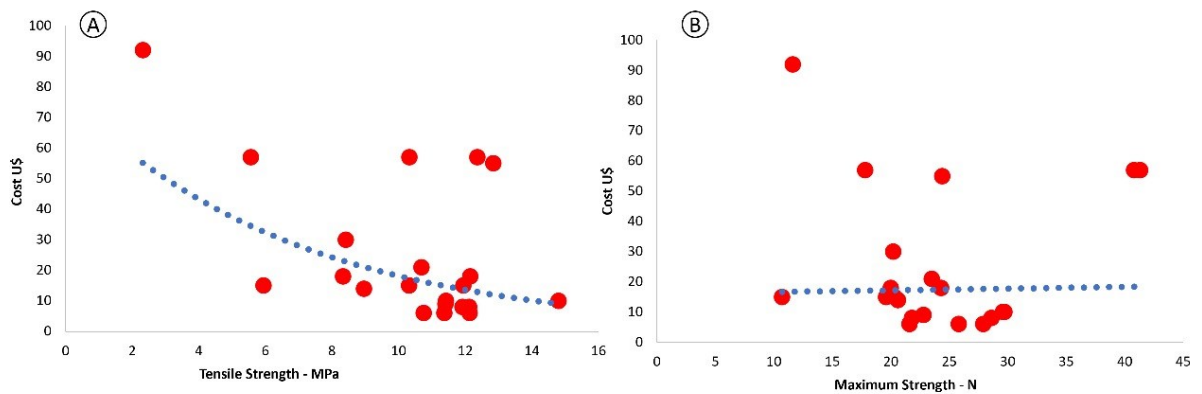


Figure 11. The correlation coefficient (r). A. Correlation coefficient of between the cost and the UTS (MPa) of the rubber dam. B. Correlation coefficient of between the cost and the RF (N) of the dental dam.

APÊNDICE B – TABELA

Rubber dam	Material	Color	Thickness category	Cost (US\$)	Manufacturer
All prime	Latex	Dark blue	Medium	6	All Prime, Brasília, DF, Brazil
Bassi	Latex	Pink	Medium	10	Bassi, Belo Horizonte, Brazil
CARE	Latex	Light blue	Medium	15	GD CARE, Azusa, USA
Dura dam	Latex	Dark Blue	Medium	14	Top Glove, Selangor, Malaysia
Ehros	Latex	Dark blue	Thick	18	Medeco International, Miami, USA
Elasti dam	Latex	Dark blue	Medium	57	Coltene Whaledent, Ohio, USA
M.K life	Latex	Purple	Medium	7	M.k Life, Rio Grande do Sul, Brazil
Madeitex	Latex	Dark blue	Medium	6	Madeitex, São José dos Campos, Brazil
Nictone	Latex	Light blue	Medium	57	MDC Dental Zapopan, Jalisco, Mexico
Nictone	Latex	Black	Medium	57	MDC Dental Zapopan, Jalisco, Mexico
Nictone	Latex	Light blue	Thick	57	MDC Dental Zapopan, Jalisco, Mexico
O.K	Latex	Light blue	Medium	10	China
Prehma	Latex	Dark blue	Medium	18	Keystone, Myerstown, USA
Pribanic	Latex	Green	Medium	15	Sanctuary, Perak, Malaysia
Sancturay	Latex	Black	Medium	14	Sanctuary, Perak, Malaysia
Sancturay	Latex	Dark blue	Medium	8	Sanctuary, Perak, Malaysia
Sancturay	Latex	Green	Medium	9	Sanctuary, Perak, Malaysia
Sancturay	Latex	Dark blue	Thick	8	Sanctuary, Perak, Malaysia
U.S.E	Latex	Green	Thick	10	U.S.E, Puchong, Malaysia
Flexi dam non latex	Non latex	Purple	Medium	90	Coltene Whaledent, Ohio, USA
Sanctuary	Non latex	Purple	Medium	40	Sanctuary, Perak, Malaysia

Table 1