Diferentes exposiciones de prótesis dentales acrílicas con códigos QR grabados con láser con fines forenses.

DIFFERENT EXPOSURES OF ACRYLIC DENTAL PROSTHESES WITH QR CODES ENGRAVED BY LASER FOR FORENSIC PURPOSES.

Briem Stamm AD[1,2], Fernández Iriarte MA[1], Zemborain CR[1], Outes María S[1], Casadoumecq AC[1], Bello JF[1], Rannelucci LR[1], Salazar JD[1], Telechea CR[1], Di Pietro S[3,4], Jaime G[4], Arias CG[1], Gualtieri AF[1]

1 Chair of Legal, Forensic Dentistry and History of Dentistry, Faculty of Dentistry, University of Buenos Aires (Buenos Aires, Argentina).
2 Section Forensic Odontology, Directorate of Criminalistics and Forensic Studies, Argentine National Gendarmerie (Buenos Aires, Argentina).
3 Chair of Endodontics, Faculty of Dentistry, University of Buenos Aires (Buenos Aires, Argentina).
4 Jaime`s Dental Laboratory (Buenos Aires, Argentina).

RESUMEN: Objetivo: Evaluar el escaneo y decodificación de códigos QR grabados con láser sobre soportes metálicos adaptados a prótesis dentales acrílicas sometidas a exposiciones térmicas y ácidas con fines forenses en identificación humana. Materiales y Métodos: Se elaboraron 150 prótesis acrílicas termocurables. Se expusieron 120 prótesis a la acción de temperaturas de 200°C, 400°C, 800°C. y 1000°C durante 30, 60 y 120 minutos (Grupo 1). Este grupo se dividió en un subgrupo 1.A que incluía 60 prótesis con el código QR grabado sobre un soporte de cromo-cobalto adaptado al acrílico y un subgrupo 1.B con la otra mitad de los aparatos protésicos, que tenían en su estructura un soporte de acero para bandas de ortodoncia con código QR. Las 30 prótesis restantes conformaron el Grupo 2 y se dividieron en el subgrupo 2.A (15 prótesis con soporte de cromo-cobalto) y el subgrupo 2.B (15 prótesis con soporte de acero para bandas de ortodoncia) todas sumergidas en ácido clorhídrico al 40% a temperatura ambiente durante 30, 60 y 120 minutos. El análisis de datos incluyó las pruebas de Chi-cuadrado de Pearson y exacta de Fisher, y regresión logística múltiple. Resultados: En el Grupo 1 la lectura positiva de los códigos QR fue del 75% para el Subgrupo 1.A y del 12% en el subgrupo 1.B. Para el Grupo 2, la lectura positiva de los códigos QR resultó en un 66% en el subgrupo 2.A y un 0% en el subgrupo 2.B. Conclusión: A pesar de los efectos deletéreos de los agentes físicos y químicos sobre el acrílico, bajo ciertas condiciones. Es posible leer e interpretar códigos QR grabados con láser sobre soportes de cromo-cobalto adaptados a la estructura protésica, lo que puede representar una alternativa para la identificación humana.

PALABRAS CLAVE: IDENTIFICACIÓN HUMANA; PRÓTESIS ACRÍLICAS; ÁCIDO CLORHÍDRICO, RESPUESTA RÁPIDA.

ABSTRACT: Objective: To evaluate the scanning and decoding of laser-engraved QR codes on metal supports adapted to acrylic dental prostheses subjected to thermal and acid exposures for forensic purposes in human identification. Materials and Methods: 150 thermo-curing acrylic prostheses were made. 120 prostheses were exposed to the action of temperatures of 200°C, 400°C, 800°C. and 1000°C for 30, 60, and 120 minutes (Group 1). This group was divided into a subgroup 1.A that included 60 prostheses with the QR code engraved on a chrome-cobalt support adapted to the acrylic and a subgroup 1.B with the other half of the prosthetic appliances, which had in their structure a support of steel for orthodontic bands with QR code. The 30 remaining prostheses made up Group 2 and were divided into subgroup 2.A (15 prostheses with chrome-cobalt support) and subgroup 2.B (15 prostheses with steel support for orthodontic bands) all submerged in hydrochloric acid 40% at room temperature, for 30, 60, and 120 minutes. Data analysis included Pearson's Chi-square and Fisher's exact tests, and multiple logistic regression. Results: In Group 1, the positive reading of the QR codes was 75% for Subgroup 1.A and 12% in subgroup 1.B. For Group 2, the positive reading of the QR codes resulted in 66% in subgroup 2.A and 0% for subgroup 2.B. Conclusion: Despite the damaging effects of physical and chemical agents on acrylic, under certain conditions. it is possible to read and interpret laser-engraved QR codes on chrome-cobalt supports adapted to the prosthetic structure, which may represent an alternative for forensic purposes in human identification.

KEY WORDS: HUMAN IDENTIFICATION; ACRYLIC PROSTHESES; HYDROCHLORIC ACID, QUICK RESPONSE.

CONTACTO: ALAM BRIEM STAMM. Email: alanbs.uba@gmail.com

1. INTRODUCTION.

Identifying human remains by denture marking methods has been reported (1) (2) Different tragic vicissitudes producing human losses, such as traffic accidents, natural catastrophes, violent offences, or terrorist attacks, implies severe challenges for the multidisciplinary forensic teams. (3) (4) Besides, the analysis of marked prosthetic appliances might facilitate the resolution of cases involving persons with amnesia, confuse conditions and unconscious victims (5) (6) Certain countries enacted laws for tagging of prostheses, (7) for example, in U.S.A. 23 from 50 States disposed be mandatory to install additions to contribute eventually to establish an unequivocal identity.(8)

According to the stipulations by the American Dental Association (A.D.A.) there are standards to identify dental prostheses. (9) As for the location of the "marking element", the posterior areas of the lingual rim in lower appliances and of the palate in the upper ones are the most recommended. (10) (11) (12)Two main methods were reported for the prosthetic identification: to mark superficially with a flat round bur letters or numbers, (13) (14) and the technique of embedding, designing directly in the laboratory the identificatory tag in the prosthetic frame. (12) (15) Through time, different strategies for prosthetic marking were suggested, like bar code, legible with a barcode scanner, although its disadvantage is scarce information storable (2) (16) Another option is the lenticular card that keeps the information in image format. (11) It also turned towards the use of stainless-steel bands with patient's data, embedded in a ledge carved previously in the surface of the prosthesis or even typed paper straps. (17) (18) A variation suggested is to use the T-bar, consisting in adapt a translucent methacrylate bar T-sized enclosed in the appliance with a tag. (19) (20) It is necessary to consider that one of the safest and most resistant methods, is to engrave with laser technology, taking into account the different situations that may endanger the integrity of a prosthesis. (6) The use of electronic microchips was advised too the information is enclosed in a microchip, measuring 5 x 5 x 0.6 mm. It is one of the most used methods for its tiny size, acceptable aesthetic and good behavior against high temperatures and acid attacks. (21) (22) (23) (24) (25) However, this means is expensive and the cost of dental prostheses is high for the patient. Identification utilizing radiofrequency (RFID) with tags measuring 8.5 x 2.2 mm2 was considered as well. (26) (27).

In turn, the QR (Quick Response) codes meant an authentic technological revolution for their low cost, easy access, and scanning, great capacity for storage of information, quick access, and decoding employing mobile telephone. (28) (29) (30) Different researches about QR codifications for tagging of dental appliances were published, although their possibilities using laser technology were not explored. (31) These works concentrated on the laser engravement of QR codes on a metallic support and embed them in the surface of thermo-cured acrylic dental prostheses, to assess their reliability when exposed to conditions of thermal and acid attacks.

The objective of this research is evaluate the scanning and decoding of laser-engraved QR codes on metal supports adapted to acrylic dental prostheses subjected to thermal and acid exposures for forensic purposes in human identification.

2. MATERIALS AND METHODS.

For this research, 150 thermo-cured acrylic prostheses with QR codes engraved by laser on supports of chrome-cobalt or steel for orthodontics bands were made (acrylic Dentsply, Acrytone teeth) to expose to conditions of thermal or acid attacks for forensic purposes in human identification.

2.1. They were divided into two groups:

2.1.1. Group I: 120 prostheses, exposed to fire; The group I was divided into two subgroups: The subgroup 1.a comprised 60 prostheses. In each prosthesis, 1 mm from its free surface was embedded a support of chrome-cobalt (Cr-Co), measuring 9 mm x 6 mm x 0,5 mm, of the mark Messa, placed close to the first molar, and it was covered with self-curing translucent acrylic (Dentsply). There was engraved with laser a QR Code of 5 mm x 5 mm containing the number of the National Document of Identity (DNI) of one of the researchers (Fig. 1).

Figure 1: QR code and DNI number engraved by laser.

The subgroup 1.b was composed by 60 prostheses with a steel support for orthodontic bands of 9 x 6 x 0,6 mm. This support was added in all prostheses at 1 mm of their free surfaces close to first molar, and it was covered by translucent self-curing acrylic (Dentsply). On its surface was engraved with laser a QR Code, measuring 5 x 5 mm, with the number of the DNI of one of the researchers.

All prostheses in the subgroups 1.A and 1.B were exposed to temperatures of 200° C (30 prostheses), 400° C (30 prostheses) 800°C (30 prostheses), and 1000° C (30 prostheses) for 30, 60, and 120 minutes. Two electric ovens were used, the first (mark Manfredi, Italian) with a heating capacity from 0 to 1,200°C, and the second (mark Tecnodont, Argentine) with a heating capacity from 0 to 1,000°C, besides an acrylic polymizer, mark Tecnodent.

Group II: comprised 30 prostheses, submerged in hydrochloric acid.

The 30 prostheses in the group 2 were subdivided as well into two groups of 15 units each. The subgroup 2.A had the chrome-cobalt support adapted on the acrylic; while the subgroup 2.B had the steel support for orthodontic bands. The prostheses of both groups were submerged in hydrochloric acid 40%, at room temperature, for 30 minutes (10 prostheses), 60 minutes (10 prostheses), and 120 minutes (10 prostheses).

To optimize the reading and interpretation of the results after the analysis of the physical and chemical effects, the scale of evaluation "Positive" (to QR codes effectively scanned) or "Negative" (to QR codes not scanned effectively) was considered.

In the context of this study, all QR Codes were engraved with the Engraving Laser System with technology supplied by "Laboratorios Romi – Sistema de Implantes Rosterdent". The only information entered through the QR codes generator software in the website (http://www.theqrcodegenerator.com/) was the number of the DNI of one of the researchers. The QR Code reader application was made through the Play Store on Smartphone devices with Gamma Play, scanning the QR code in seconds. The hydrochloric acid was purchased through a trading company.

2.1.2. Inclusion criteria: The supports of chrome-cobalt and steel for orthodontics bands, with the QR Code containing the number of DNI engraved by laser, were verified before their inclusion in the thermos-cured prostheses through reading and decoding, using mobile telephones Samsung J7, iPhone X, and Galaxy S9. If the results were positive, they were used in the research (Fig. 2).

Figure 2: Acrylic prosthesis prepared for exposure to fire or hydrochloric acid 40%.

2.1.3. Exclusion criteria: The supports of chrome-cobalt and steel for orthodontic bands, before their adaptation on the surface of the thermos-cured acrylic prostheses, with a "negative reading" of the QR Code (containing the number of DNI), would be discarded for the experimentation.

In the analysis of the results, the description of categorical variables included absolute frequencies and percentages with 95% confidence intervals (CI95) estimated using the Wilson score method. To assess association in bivariate analyses, Pearson's Chi-square or Fisher's exact tests were used, as applicable. That is, when all the expected frequencies were equal to or greater than 5, the Chi-square test was used. Otherwise, Fisher's exact test was used.

In prostheses exposed to fire, to find independent predictors of the reading result (positive or negative), a multiple logistic regression was performed using the gradual method ($p<0.05$, entry; $p>0.1$, removal). The logistic analysis included three independent variables: support, temperature, and time. The reference categories were the following: Cr-Co, 200 °C, and 30 min, respectively.

In prostheses immersed in 40% hydrochloric acid (HCl), the description of the results according to support and time only included absolute frequencies. Percentages were not shown because the total number of observations was considered to be relatively small. For this same reason, a multivariate analysis was also not performed for the treatment with HCl (40%).

Values $p<0.05$ were considered statistically significant.

The following programs were used: R v. 4.1.3 (32) with base packages, DescTools (33) and ggplot2, (34) and MedCalc v. 20,110). (35) R was used to estimate CI95 of percentages (33) perform Chi-square and Fisher's exact tests (base) and make the figures (ggplot2). Multiple logistic regression was performed with MedCalc. (35)

2.1.4. Exclusion criteria: The supports of chrome-cobalt and steel for orthodontic bands, before their adaptation on the surface of the thermos-cured acrylic prostheses, with a "negative reading" of the QR Code (containing the number of DNI), would be discarded for the experimentation.

In the analysis of the results, the description of categorical variables included absolute frequencies and percentages with 95% confidence intervals (CI95) estimated using the Wilson score method. To assess association in bivariate

analyses, Pearson's Chi-square or Fisher's exact tests were used, as applicable. That is, when all the expected frequencies were equal to or greater than 5, the Chi-square test was used. Otherwise, Fisher's exact test was used.

In prostheses exposed to fire, to find independent predictors of the reading result (positive or negative), a multiple logistic regression was performed using the gradual method ($p<0.05$, entry; $p>0.1$, removal). The logistic analysis included three independent variables: support, temperature, and time. The reference categories were the following: Cr-Co, 200 °C, and 30 min, respectively.

In prostheses immersed in 40% hydrochloric acid (HCl), the description of the results according to support and time only included absolute frequencies. Percentages were not shown because the total number of observations was considered to be relatively small. For this same reason, a multivariate analysis was also not performed for the treatment with HCl (40%).

Values $p<0.05$ were considered statistically significant.

The following programs were used: R v. 4.1.3 (R Core Team, 2022) (33) with base packages, DescTools (Signorell et al., 2021) (34) and ggplot2 (35) and (32) R was used to estimate CI95 of percentages (DescTools package), (34) perform Chi-square and Fisher's exact tests (base) and make the figures (ggplot2). Multiple logistic regression was performed with MedCalc.(32)

3. RESULTS.

3.1. Prostheses exposed to fire.

Among the 120 prostheses exposed to fire, there were 55 positive results (46%; CI95: 37% to 55%) and 65 negatives (54%; CI95: 45% to 63%). Bivariate analysis (Table 1) indicates that the reading result was significantly associated with support ($p<0.0001$), temperature ($p<0.0001$), and time ($p<0.01$). When Cr-Co and steel supports were used, the result was positive in 75% (95 CI: 63% to 84%) and 17% (95 CI: 9% to 28%) of the observations, respectively (Fig. 3). The following positive results percentage was found at the temperatures of 200°C (83%), 400°C (50%), 800°C (33%), and 1000°C (17%) as demonstrated in Fig. 4.

Figure 3. Result of the reading according to the support in prostheses exposed to fire. Stacked Bar Chart: The values inside the bars indicate the percentages of positive and negative results for each support.

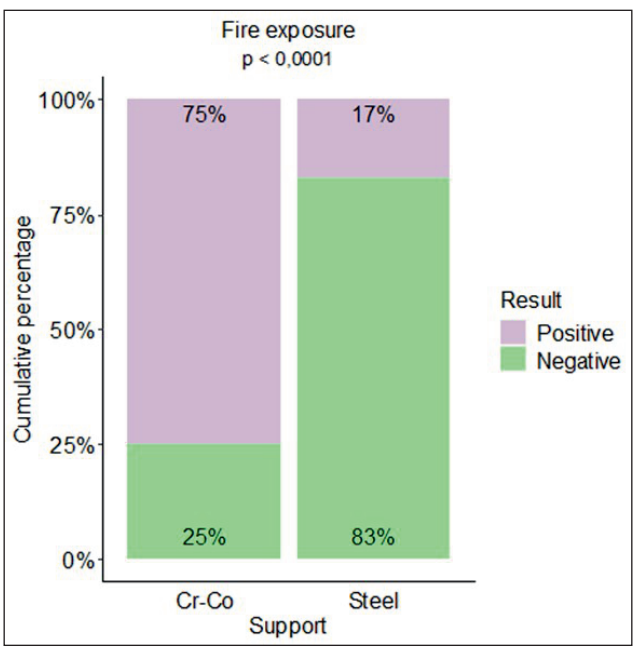
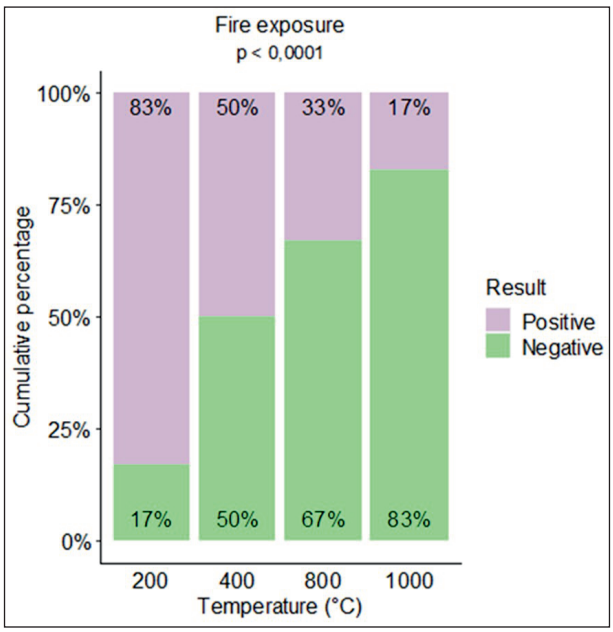


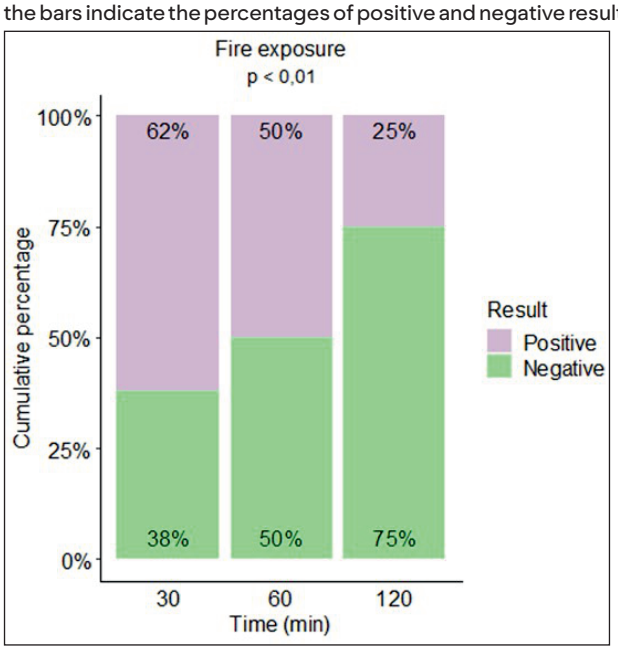
Figure 4. Result of the reading according to the temperature in prostheses exposed to fire. Stacked Bar Graph: The values within the bars indicate the percentages of positive and negative results for each temperature.



In the different times of exposures, the percentage of positives results obtained were 30 minutes (62%), 60 minutes (50%), and 120 minutes (25%) (Fig. 5).

The three variables significantly associated with the reading results in the bivariate analysis (support, temperature, and time) were included in a multiple logistic regression analysis. According to this multivariate analysis, there are two independent predictors of a negative result (Table 2): steel support (OR = 30.4; CI95: 9.7 to 95.1) and temperature of 1000°C (OR = 18.1; CI95: 4.6 to 70.7).

Figure 5. Result of the reading according to time in prostheses exposed to fire. Stacked bar graph: The values inside the bars indicate the percentages of positive and negative results for each time.



3.2. Prostheses submerged in 40% hydrochloric acid (HCl) solution.

Among the 30 prostheses immersed in HCl solution (40%), there were 10 positive results (33%; 95% CI: 19% to 51%) and 20 negative results (67%; 95% CI: 49% to 81%). Bivariate analysis (Table 3) indicates that reading outcome was significantly associated with support ($p<0.001$) and time ($p<0.05$).

Within the 15 Cr-Co supported systems, there were 10 positive results. In contrast, in the 15 prostheses that had steel support, the result was completely negative (Fig. 6). Within the 30 minutes and 60 minutes' exposures, 5 of the 10 prostheses had a positive result. In contrast, in the 120 minutes' exposures, all 10 observations were negative (Fig. 7).

4. DISCUSSION.

One of the most used strategies in the last years in forensic dentistry was based on the tagging of dental prostheses. (36) (37) (38) But the main disadvantage appears in situations of extreme temperatures when the plastic materials evaporate and the metallic or ceramic structures, full or partial, become adequate vehicles with certain tolerance. (36) (37) (39) The systems of codification 1D ("bar codes"), different types of codification 2D (Code 49, pdf417, 2d Matrix), and especially the very successful and consolidated QR codes were presently considered as adequate technologies to identify and manage sanitary information in situations of low budget. (31) (40) The QR code was developed in Japan by the Denso Wawe Corp., a subsidiary of Toyota. To differ with the "barcodes" (1D), the codes 2D, like the QR code, use dots instead of lines to store an important amount of information, represented in thousands of characters. Thanks to the possibility to codify a hyperlink (URL) the reading of the code will favor any mobile device can access quickly and without any typing specific sites where the searched information is safeguarded. (29) (30) The information accessible through these codes include pictures, demographic data, weight, stature, blood group, hair and eye color, dental files, fingerprints, personal and filiation data, etc. (29) (31) Thus, the great development of telephonic applications showed efficacy to read and interpret medical and epidemiological data.

The QR code is detected as a digital bi-dimensional image through an image sensor, then is analyzed by a programmed processor (41) (42) They are accurate, of less cost and they store a great amount of data (29) If printing the QR code on paper, its siz e will be directly proportional to the amount of information included. In the present search, when the QR code was generated with laser technology, was engraved with a size of 5 x 5 x 5 mm (At 50 pixels) (Fig. 4).

Figure 6. Result of the reading according to the support in prostheses immersed in HCl solution (40%). Stacked bar chart: The values inside the bars indicate the absolute frequencies (N) of positive and negative results for each support.

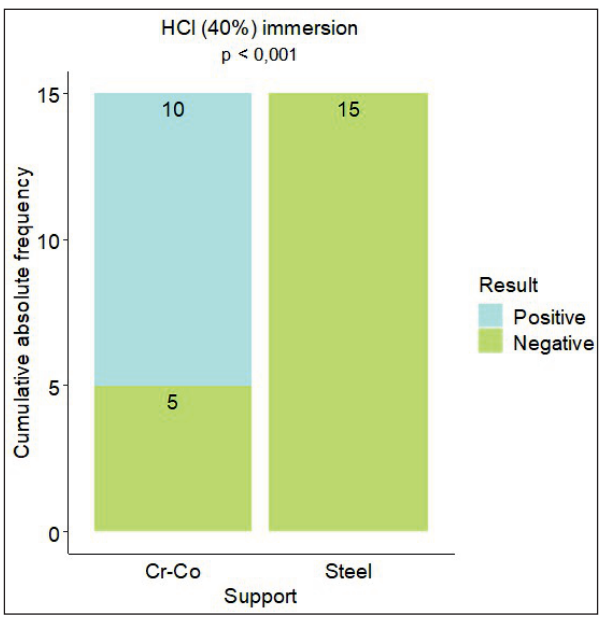
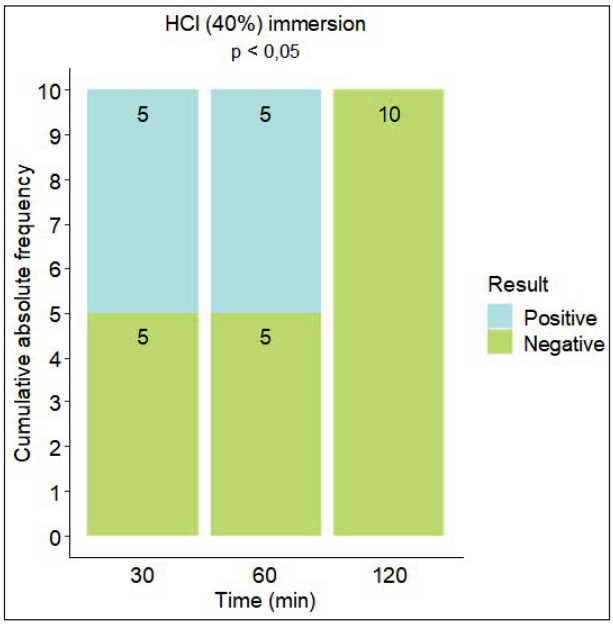


Figure 7. Result of the reading according to time in prostheses immersed in HCl solution (40%). Stacked bar graph: the values inside the bars indicate the absolute frequencies (N) of positive and negative results for each time.



Within prostheses exposed to fire, the results suggest that the reading and interpretation of the QR code are favored when Cr-Co supports are used, while it is not favored at a temperature of 1000 °C. For treatments with HCl (40%) the results are less conclusive because a relatively small sample size prevented a multivariate analysis. But the trend that emerges from the bivariate analysis is that the positive results would be related to Cr-Co supports and times of 30 or 60 minutes.

5. CONCLUSIONS.

Despite the damages of the physic and chemical agents on the thermo-cured acrylic, under certain conditions was possible to read and interpret QR codes engraved digitally with laser on chrome-cobalt supports adapted to the prosthetic structure; The versatility and celerity for decoding and reading the information enclosed in ~~such~~ the QR codes foresee a great potential for forensic dentistry. It could represent an alternative for human identification.

Larger studies that could include fully metallic prostheses, like those of chrome-cobalt, or even dental implants, may represent feasible variables to promote and consolidate standardizing and regulatory aspects about the necessity of tagging dental prostheses~~,~~ with forensic purposes in the Argentine Republic.

6. REFERENCES.

1. MACENTEE M, CAMPBELL T. Personal Identification using dental prostheses. J Prosthet Dent. 1979;(80). https://doi.org/10.1016/0022-3913(79)90032-5
2. RICHMOND R, PRETTY I. Denture marking - Patient preference of various methods. Forensic Sci. 2007; 52: p. 1338-42.
3. BERNITZ H. The challenges and effects of globalization on forensic dentistry. In Dent. 2009; 59.
4. INTERPOL. Identificacion de victimas de catastrofes. En INTERPOL. Organizacion Internacional de Policia Criminal.; 2018.
5. BERRY F, LOGAN , PLATA R, RIEGEL R. A postfabrication technique for identification of prosthetic devices. Prosthet Dent. 1995; 216(11): p. 615-7.
6. KALYAN A, CLARK RK, RADFORD DR. Denture identification markinh should be standard practice. Br Dent. 2014; 216(11): p. 615-7.

7. GOSAVI S. Forensic odontology: A prosthodontics view. Forensic Dent Sci. 2012;(4): p. 38-41.

8. CARDOZA AR, WOOD JD. Atypical forensic dental indetifications. Calif Dent Assod. 2015; 43: p. 303-8.

9. American Dental Association (ADA).

10. COSS P, WOLFAARDT J. Denture Identification system. Prosthet Dent. 1995; 74.

11. COLVENKAR SS. Lenticular card: a new method for denture identification. Indian J Dent Res. 2010; 21(1): p. 112-4.

12. CORTES V, CARRASCO F, VERGARA C. Prevalence of partial and total edentulism in Butachauques and Tac Islands, Quemchi (Chile). Rev Chil Salud Publica. 2014; 18(3): p. 257-262.

13. LAMB DJ. A simple method for permanent identification of dentures. Prosthet Dent. 1992;: p. 67-894.

14. ACHARYA AB, ANEHOSUR GV, KANCHI PP, NAIK MG, NADIGER RK. Perceptions and preferences on dentures marking in an Indian simple. Gerodontology. 2012; 29(2): p. 117-24.

15. BANSAL PK, SHARMA A, BHANOT R. Denture labeling: a new approach. Contemp Clin Dent. 2011; 2(2): p. 76-8.

16. DATTA P, SOOD S. The various methods and benefits of denture labeling. Forensic Dent Sci. 2010; 2(2): p. 53-8.

17. BENGTSSON A, OLSSON T, RENÉ N, CARLSSON G, DAHLBOM U, BORRMAN H. Frequency ofedentulism and identification marking of removable dentures in long-term care units. Oral Rehabil. 1996; 23(8): p. 520-3.

18. BORRMAN HI, RENE MJ, WASÉN J. Denture marking: a questionnairefor patients and dentists. J of forensic odontostomatology. 1997; 15: p. 30-36.

19. RYAN LD, KELLER JB, ROGERS DE, SCHAEFFER L. Clear acrylic resin T-bar used in denture identification. prosthet Dent. 1993; 70: p. 189-90.

20. REESON MG. A simple and inezpensive inclusion technique for denture identification. Prosthet Dent. 2001; 86: p. 441-2.

21. IBRAHIM WM. Denture microlabeling technique. Prosthet Dent. 1996; 76: p. 104.

22. LING B. Computer printer denture microlableing system. Prosthet Dent. 1998; 79: p. 363-4.

23. MILLET C, JEANNIN C. Incorporation of microchips to facilitate denture identification by radio frequency tagging. Prosthet Dent. 2004; 92: p. 588-90.

24. MAZZA A, MERLATI G, SAVIO C, FASSINA G, MENGHINI P, DANESINO P. Observations on dental structures when placed in contact with acids: Experimental studies to aid identification processes. Forensic Sci. 2005; 50: p. 406-10.

25. LUTHRA R, ARORA S, MESHRAN S. Denture Marking for forensic identification using memory card: anninnovativetechnique. Indian Prosthodont Soc. 2012; 12(4): p. 231-5.

26. MATSUMURA H, SHIMOE S. Incorporation of a cast, embossed identification plate into a partial denture framework. Prosthet Dent. 2002; 88: p. 215-7.

27. MADRID C, KORSVOLD T, ROCHAT A, ABARCA M. Radio frequency identification plate into a partial denture framework. Prosthet Dent. 2002; 107(3): p. 199-202.

28. RAJENDRAN V, KARTHIGEYAN S, MANOHARAN S. Denture Marker using a two-dimensional bar code. Prosthet Dent. 2012; 107(3).

29. SUDHEENDRA US, SOWMYA K, VIDHI M, SHREENIVAS K, PRATHAMESH J. 2D Barcodes: a novel and simple method for denture identification. Forensic Sci. 2013; 58(1): p. 170-2.

30. RAGAVENDRA TR, MHASKE S, GOURAHA A, YUWANATHI M, KAMATH KP. Quick response cod in acrylic denture: willit respond henneeded? Forensic Sci. 2014; 59(2): p. 514-6.

31. FONSECA GM, CANTIN M, RAGAVENDRA TR, MHASKE S, GOURAHA A, YUWANATHI M, et al. Quick response code in acrylic denture: will it respond when needed? Forensic Sci. 2014.

32. Medcalc Statiscal Software. MedCalc Software ltd. 2022.

33. R Core Team. A language and enviroment for statistical computing. 2022.

34. SIGNORELL A, AHO K, ALFONS A, ANDEREGG N, ARAGON T, ARACHCHIGE C. Desc tools: Tools for descriptive statistics. 2021.

35. WICKHAM H. Elegant graphics for Data Analysis.

36. AGÜLOĞLU S, ZORTUK M, BEYDEMIR K. Denture barcoding: A new horizon. Br Dent. 2009; 206: p. 589-90.

37. RICHMOND R, PRETTY I. Identification of the edentulous individual: an investigation into the accuracy of radiographic identifications. Forensic Sci. 2010; 55(4): p. 984-7.

38. NAITO Y, MEINAR AN, IWAWAKI Y, KASHIWABARA T, GOTO T, ITO T, et al. Recording of individual identication information on dental prostheses using fluorescent material an ultraviolet light. Prosthodont. 2013; 26(2): p. 172-4.

39. DELATTRE VF. Burned beyond reongnition: Systematic approach to the dental identification of charred human remains. Forensic Sci. 2000; 45: p. 589-96.

40. KAREKER N, ARAS M, CHITRE V. A review on denture marking systems: a mark in forensic dentistry. Indian Prosthodont soc. 2014; 14(suppl 1): p. 4-13.

41. GARCIA BETANCES RL, HUERTA MK. A review of automatic patient identification options for public health care centers with restricted budgets. 2012; 4(1): p. 9.

42. SEKYERE K. QR Codes in libraries: Uses and Usage Tracking. College & undergraduate libraries. 2012; 19: p. 95-100.x