DOCTORAL DISSERTATION

Doctoral Program in Bioengineering and Medical-Surgical Sciences

(35th Cycle)

COMPARATIVE EVALUATION OF POST-OPERATIVE QUALITY OF LIFE FOLLOWING ROOT CANAL TREATMENT AND FILLING WITH NOVEL BIOCERAMIC SEALER

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*maximal pain, MAX; impact on overall quality of life, QOL; analgesic intake, AI

COMPARATIVE EVALUATION OF POST-OPERATIVE QUALITY OF LIFE FOLLOWING ROOT CANAL TREATMENT AND FILLING WITH NOVEL BIOCERAMIC SEALER

INTRODUCTION

Postoperative pain (POP) after root canal filling is a relevant issue in endodontic patients that affects up to 40% of cases [1]. The intensity and duration of POP vary based on multiple prognostic factors [2, 3, 4]. Amongst these the impact of the filling technique is considered to be especially significant. [5, 6]. We evaluate the influence of various obturation sealers and techniques on pain levels, overall quality of life and analgesic intake post filling treatment. Additionally, we examine the potential correlation between pre-operative variables and pain levels prior to treatment as well as following shaping and filling treatment. Finally, we delve into the detailed pain variables following filling treatment.

Pre-op dental status

The initial clinical situation, the conditions of the pulp, periodontal status, diagnosis and other pre-op parameters may exert an influence on POP. Mekhdieva et al.'s systematic review and meta-analysis [7] demonstrate that POP was lower in teeth with vital pulp when filled with RBS and in teeth with non-vital pulp when filled with BCS. However, no additional literature was found to provide context for this observation. This study also revealed a non-significant difference in POP in favor of RBS at retreatment. Furthermore, Graunaite et al. [8] reported that this parameter indicates no difference between filling techniques in POP following retreatment procedures.

In Bashetty et al.'s study [9], teeth with vital pulp undergoing endodontic treatment are found to be associated with reduced POP. Asymptomatic necrotic pulp accompanied by a periapical lesion emerges as the most probable pre-disposing clinical condition leading to post-operative pain. Conversely, NaOCl, owing to its dissolution capability, can be detrimental to periapical tissues, and may be linked to both pain and acute inflammation. However, discerning the relationship between pulp condition and post-operative pain based on varied irrigation solutions is beyond the scope of this systematic review.

For these reasons, in this study, we sought to analyze the potential correlation between pre-operative clinical status variables and POP parameters.

Instrumentation

Mechanical preparation, also known as instrumentation, is designed to remove pulpal tissue, eradicate microorganisms and shape the canals to facilitate proper disinfection and filling. The type of instrumentation – be it manual or rotary/ reciprocating – has an impact on POP. The primary cause of POP during this phase of treatment stage is the extrusion of dentin debris [3, 4, 5]. This extrusion occurs irrespective of the canal preparation technique, whether it is manual or engine-driven instrumentation [6, 7]. When comparing these types of Ni-Ti instruments, it is preferable due to its providing a more centralized preparation of the root canal [10], and its propensity to cause less debris extrusion compared with manual instruments [11, 12]. The extrusion of infected debris can either exacerbate an existing inflammatory process or initiate periapical inflammation, leading to POP [13]. The motion of the reciprocating type of instrument involves an initial rotation of the endodontic file in a counter-clockwise direction, allowing it to penetrate and cut the dentin. It then rotates in the opposite direction, during which the file is released [14]. According to Pasqualini et al. [15], root canal instrumentation with rotary files tends to yield a more favorable time-efficiency result and results in lower POP. High levels of additional variables, such as difficulty in eating, performing daily activities, sleeping, and engaging in social relations are more pronounced following reciprocating instrumentation. The meta-analysis by Silveira et al. [16], also indicates a significant difference in postoperative pain, with rotary instrumentation being the more favorable. The studies of Burklein et al. further affirm that rotary instrumentation exhibits superior performance in terms of debris extrusion compared to reciprocating systems. [17, 18]. In contrast, Silva et al. [19], observed that reciprocating instruments extruded significantly less debris. Drawing on the results of this meta-analysis [20], one can deduce that the incidence of postoperative pain following the use of Ni-Ti instruments is low, with reciprocating systems causing more pain within the first 24 hours post-treatment. Overall, the incidence and level of postoperative pain did not vary between reciprocating and rotary systems. Additionally, Nobar et al [21] emphasize that there is no statistically significant difference in postoperative pain outcomes at the 12, 24, and 48 hour marks.

Given the heterogeneity of previous findings, in this study, we opted to use a single type of rotary instrumentation – ProTaper Next – with the aim of minimizing any influence this treatment stage might have on POP.

Irrigation

Chemical cleaning of the root canal system aims to eradicate microorganisms, remove and dissolve debris, and lubricate instruments during shaping. Various types of chemical solutions are available, differentiated by their percentages and activation techniques. These also may exert an influence on POP.

According to Adam et al. [22] conventional syringe irrigation remains the most popular technique alongside other techniques such as manual dynamic activation, negative pressure aspiration and sonic or ultrasonic agitation. Proponents of such techniques argue that better delivery of the irrigant to the root canal system facilitates a greater degree of disinfection, with potentially less post-operative pain, a common and undesirable side effect of root canal treatment. However, according to Pak et al. [23] ultrasonic irrigation may lead to less post-operative pain compared to conventional irrigation techniques, although there was limited evidence for this assertion. The systematic review and meta-analysis conducted by Martins et al. [24] explored the impact of various chemical solutions on POP. However, but data was insufficient to draw a definitive conclusion.

To prevent confounding variables in this study, we employed a singular irrigation method with manual activation using 5.25% sodium hypochlorite.

Filling technique and filling sealer

A key factor that may affect POP at this stage of treatment is the decision to use or not use high temperature when filling root canals. The most well-known and widely adopted techniques include the so-called single cone, warm vertical compaction and the carrier-based technique. Additionally, two primary types of filling sealers are available: resin-based and the newer bioceramic groups. The chemical structure and physical properties of these sealers may also have an impact on POP after filling.

The bioceramic sealer filling technique has recently gained popularity amongst endodontists, largely attributed to the benefits of bioceramic sealers. These benefits are notably their biocompatibility (due to their similarity with biological hydroxyapatite) and their ability to promote periapical healing [25]. Critical attributes such a 30 minute setting time, effective sealing and antimicrobial properties contribute significantly to the performance of endodontic sealers [26]. For convenience, they are available in premixed injectable formulations, as well as paste in preloaded syringes and even in moldable putty form. [27]. However, controlled randomized trials have yet to reach a consensus on POP outcomes when comparing bioceramic sealers (BCS) with traditional filling techniques

According to Mekhdieva et al (2022) [7] a meta-analysis of nine pooled RCTs indicates that POP was significantly lower following root canal filling with bioceramic sealer compared to a resin-based sealer. However some of the RCTs individually reported no significant effect of bioceramic vs. resin-based sealer on POP [28, 29, 30, 31, 32, 33, 34, 35, 36].

The pooled analysis from this systematic review and meta-analysis [7] suggests that while bioceramic sealers are favored in both warm vertical and single cone obturation techniques, there is a likelihood of increased POP is in the group using the warm vertical filling with resin-based sealers. However, within the bioceramic group, no statistically significant difference exists between the obturation techniques.

In this study we examined the influence of two primary filling techniques on POP: the single cone, cold, technique (_c) and the warm vertical technique (_w). We used both types of sealers: bioceramic (BC_) and resin-based (AH_).

For the long-term results, we assessed the impact of pain variables on both the detailed and overall quality of life as well as the analgesic intake.

The **aim** of this study is to evaluate the impact of two filling techniques – the BC and the traditional filling technique - on POP pain in adult patients after RCF. Specifically, we aim to:

- Examine the possible correlation between the pre-operative variables and pain levels prior to treatment.
- Assess pain levels after the shaping and filling treatment.
- Investigate the influence of different obturation sealers and techniques on pain intensity, overall quality of life and analgesic intake post- filling.
- Analyze the detailed pain variables subsequent to the filling procedure.

MATERIALS AND METHODS

Study design

The study assessed the POP pain levels, analgesic intake, overall quality of life, and other detailed variables following RCF with both BC and traditional filling techniques, considering the pre-operative status of the teeth in adult patients

Review question: In patients undergoing root canal treatment, does the bioceramic filling technique influence POP intensity as compared to the resin-based sealer?

Designed as a randomized controlled clinical trial with a four parallel groups structure this research adheres to and is reported in line with the CONSORT guidelines (Schulz et al. 2010). The study was authorized by the Città della Salute e della Scienza Ethics Committee and Review Board. All participating individuals gave their informed written consent for participation in the study, which was performed in alignment with the most recent principles of the Helsinki Declaration (WMA 2000).

Null hypothesis (H0): BC filling does not affect the POP intensity compared with resin-based sealers in adult patients undergoing root canal treatment.

Cochrane PICO formula is defined by the following characteristics:

Population (P), adult patients of both gender (not undergoing antibiotic medications, without long-term use of medications, not pregnant) with pulpal and/or periapical disease (without procedural errors e.g. overfilling), who received endodontic treatment in permanent teeth;

Intervention (I), root canal filling with a bioceramic endodontic sealer;

Comparison (C), root canal filling with a resin-based endodontic sealer;

Outcome (O), the primary outcome is quality of life, postoperative pain (POP) score based on self-report evaluation, analgesic intake, impact on detailed variables (ability to speak, sleep, etc.);

Study design (S), RCT.

Interventions

The medical and dental status and histories of each patient were collected. Intra-oral examinations were conducted using 3.5X loupes, and both pulpal and periradicular statuses were evaluated with thermal and electric pulp tests as well as palpation and percussion. Periodontal status was also documented. Periapical radiographic examinations were carried out using Rinn XCP devices. Teeth with a loss of lamina dura and periodontal ligament enlargement of more than 2 mm were classified as having lesions of endodontic origin (LEO). Clinical and radiological data were scrutinized by three blinded examiners selected from among the clinical assistant professors within the Endodontic Department. Where opinions diverged, agreement was reached through discussion. Examiners were calibrated to the evaluation criteria via a case series presentation and examiner concordance was analyzed using the Fleiss' K score, ensuring inter-examiner reliability (K > 0.70) was attained. Clinical cases were classified as minimal, moderate or high difficulty in line with the American Association of Endodontists (AAE) Endodontic Case Difficulty Assessment. All treatments were performed by experienced operators who had followed a postgraduate course in Endodontics and had more than three years of experience. After administering local anesthesia, the tooth was isolated with a rubber dam. An access cavity was prepared, followed by endodontic pre-treatment to ensure an adequate reservoir for the irrigant solutions. A mechanical glide path was established using ProGlider. An endodontic motor (X-Smart, Dentsply), 16:1 contra angle was used at the recommended settings (300 rpm on display, 4.2 Ncm) to achieve the working length (WL). The electronic WL was recorded with an apex locator and checked three times during treatment. The initial WL was recorded with a size 10 stainless-steel K-File during canal scouting and the initial glide path, using an electronic apex locator. A second WL was recorded after the definitive glide path with a size 17 K-File using an electronic apex. Each canal was shaped using ProTaper Next™ (Dentsply) X1 and X2. The definitive WL was checked with a size 17 K-File after X1 and shaping was accomplished with X2 at WL, with X-Smart motor using the recommended settings. Apical patency was established and confirmed with a size 10 K-File 0.5 mm beyond the apex. The irrigation was performed with a syringe and 30 G endodontic needle and with 5% NaOCl and 10% EDTA), for a total of 20 mL each. The root canals were dried with sterile paper points. The initial appointment was concluded with a temporary filling of Cavit Kerr.

Over the following three days patients were required to complete a self-questionnaire.

One week later, during a subsequent appointment, the root canal filling was completed using one of 4 distinct techniques:

1) single cone technique and bioceramic sealer (BC_c);

2) warm vertical technique and bioceramic sealer (BC_w);

3) single cone technique and resin-based sealer (AH_c);

4) warm vertical technique and resin-based sealer (AH_w).

The access cavity was sealed with temporary CVI filling and the patients were scheduled for subsequent post-endodontic restoration. The patients were discharged with post-operative instructions and a prescription for analgesics should they require them.

Eligibility criteria

Healthy subjects of both genders, who had given informed consent and were attending the Endodontic Department of Turin Dental School, were consecutively enrolled until the desired sample size was achieved.

Inclusion criteria

The study included patients with either a single or multi-rooted tooth diagnosed with asymptomatic irreversible pulpitis (evidenced by deep caries reaching the pulp upon excavation, pre-operative absence of symptoms, and normal response to thermal tests), symptomatic irreversible pulpitis, or pulp necrosis, whether accompanied by apical periodontitis (symptomatic or asymptomatic). Each of these patients was slated for primary root canal treatment.

Exclusion criteria

Patients with sinus tract, periapical abscess or other complications were not included due to these conditions potentially misrepresenting the quality of life perceptions independently of the treatment. Patients with physical or psychological disabilities or inability to understand study instructions were excluded.

Outcomes

Primary outcomes:

POQoL was evaluated with an ad hoc prepared questionnaire immediately the treatment was completed. The questionnaire evaluated mean and maximal pain, difficulty in chewing, speaking, sleeping, carrying out daily functions, social relations, and overall QoL ranging from 0 (none) to 10 (maximal impact). The parameters were evaluated by self-assessment over 72 hours (three times, every 24 hours after the medical treatment).

Secondary outcomes:

The detailed and overall quality of life evaluated by the impact on patients' normal ability to eat, speak, sleep, perform social relation and others, along with analgesic intake, evaluated by the number of analgesic tablets taken in the post-operative period, were considered as secondary outcomes.

The questionnaires were progressively code numbered and returned anonymously in a collecting box. Only the principal investigator was aware of the connection between the codes and the patients, and was excluded from the data analysis.

Study records and Data extraction

Sample size

In order to detect a ‘conservative’ between-group difference of 5% in post-operative pain (Pasqualini et al. 2012) and considering an alpha error = 0.05 to reach a power (1 - beta) of 80%, the required sample size was minimum 20 patients per group.

Randomization

The randomized sequence was generated using computer-assisted tables. To ensure group comparability and account for potential confounders, parameters such as mean pain prior to treatment and clinical diagnosis were used for randomization.

An operator, unrelated to the clinical treatment, prepared sealed envelopes containing the randomized assignments for each patient. This operator then relayed the allocation to the treating clinician following the initial patient evaluation but before the root canal filling.

Blinding

The clinicians conducting the procedures were aware of the allocation group, as distinct techniques are required for each treatment arm. However, the processes of randomization, allocation, and statistical analysis were overseen by blinded operators.

Statistical methods

The patients were considered the statistical unit of analysis. Various tests, including the Shapiro-Francia, Shapiro-Wilk, Skewness, and Kurtosis tests, were used to assess the normality of the distribution of quantitative variables. An appropriate analysis of variance model for repeated measures, involving four comparison groups, was employed to contrast the shifts in indicator-scale values noted by each group over the three days following treatment. The Spearman correlation coefficient test was utilized to gauge the correlation between pre-operative and post-operative pain variables. To determine the statistical significance of variations in pain variables over time, the Friedman test was applied. Ordered regression models evaluated the influence of pre-operative variables and different treatment stages on pain metrics and the overall impact on quality of life. The Tukey test was used to discern differences between obturation groups. Both the Student's t-test and the Kruskal-Wallis test assessed the significant disparities in post-operative pain, analgesic intake, overall quality of life, and other detailed pain parameters.

Estimates were represented as odds ratios (OR) and relative 95% confidence intervals (95% CI), reciprocally adjusted for age, gender, clinical factors and difficulty of the case. The level of statistical significance was set at $P < 0.05$. All statistical analyses were performed using the Stata BE 17 software package (USA), 2021.

RESULTS

I. DESCRIPTIVE STATICTICS. ASSESSMENT OF THE DATA NORMALITY DISTRIBUTION

The data from the 74 variables we collected can be grouped into several clusters. Firstly we collected general patient information such as gender and age, as well as information about the pre-operative status of the tooth scheduled for treatment. This cluster includes specifics such as tooth type, occlusion, the presence and number of proximal contacts, and the execution of the occlusal adjustment. Additionally, clinical parameters such as pulpal and periapical tissue condition were taken into account with the difficulty level in line with the AAE classification. The next cluster relates to the pain level patients experienced on the base point prior to treatment, on the first, second and third day after the first treatment intervention (shaping) and following the second clinical intervention that was held 1 week later (filling). Detailed information about the data and all 74 variables can be found below, in the explanatory Tab.1.

Tab.1 Explanatory table of collected variables.

Variable	**№**	**Code**	**Description**			
Gender	1	**/ gender**	1- male	2-female		
Age	2	**/ age**	3 (30-39 y.o.)	4 (40-49	5 (50-59	6 (60-69

				y.o.)	y.o.)	y.o.)
Tooth type	3	**/ ttype**	single-rooted (1)	multi-rooted (2)		
Proximal contacts	4	**/ prox_cont**	0-proximal contacts are absent	1-one proximal contact	2-two proximal contacts	
Occlusion	5	**/ occl_adj**	0-occlusal adjustment wasn't performed	1-occlusal adjustment was performed		
	6	**/occl**	0-the tooth isn't in occlusion	1-the tooth is in occlusion		
Pulp tissue conditions	7	**/ pulp**	1-assymptomatic irreversible pulpitis **/asympt_irrev_pulp**	2-symptomatic irreversible pulpitis / **sympt_irrev_pulp**	3-pulp necrosis **/ pulp_necro**	
Periodontal	8	**/ acute_perio**	0-normal	1-painful percussion		

tissue conditions			percussion		
	9	**/ chron_perio**	0-the absence of LEO*	1-LEO* = 1-2 mm	2-LEO* > 2mm
AAE classification**	10	**/ AAE****	1-low level of the case difficulty	2-moderate level of the difficulty	3-high level of the difficulty
BASE levels of pain, influence on patients' life and analgesic intake	12	**/ BASEmean**	Level of mean pain during the day before the treatment		0 min – 10 max
	13	**/ BASEmax**	Level of max pain during the day before the treatment		0 min – 10 max
	14	**/ BASEeating**	Level of pain hindering the patient's ability to eat		0 min – 10 max
	15	**/ BASEdaily_funct**	Level of pain hindering the patient's ability to perform daily functions		0 min – 10 max
	16	**/ BASEspeaking**	Level of pain hindering the patients' ability to speak		0 min – 10 max
	17	**/ BASEsleeping**	Level of pain hindering the patient's ability to sleep		0 min – 10 max
	18	**/ BASEsocial_relat**	Level of pain hindering the patient's ability to engage in social relations		0 min – 10 max

	19	**/ BASEqol**	Level of the pain hindering the patient's overall quality of life	0 min – 10 max
	20	**/ BASEai**	Number of analgesics consumed	№
Levels of pain, influence on patients' life and analgesic intake after Shaping treatment	21, 22, 23	**/ D1Smean / D2Smean / D3Smean**	Level of mean pain during the first/ second/ third day after the shaping treatment	0 min – 10 max
	24, 25, 26	**/ D1Smax / D2Smax /D3Smax**	Level of max pain during the first/ second/ third day after the shaping treatment	0 min – 10 max
	27, 28, 29	**/ D1Seating / D2Seating / D3Seating**	Level of pain hindering the patient's ability to eat during the first/ second/ third day after the shaping treatment	0 min – 10 max
	30, 31, 32	**/ D1Sdaily_ funct / D2Sdaily_ funct / D3Sdaily_ funct**	Level of pain hindering the patient's ability to perform daily functions during the first/ second/ third day after the shaping treatment	0 min – 10 max
	33, 34, 35	**/ D1Sspeaking / D2Sspeaking / D3Sspeaking**	Level of pain hindering the patient's ability to speak during the first/ second/ third day after the	0 min – 10 max

			shaping treatment	
	36, 37, 38	**/ D1Ssleeping** **/ D2Ssleeping** **/ D3Ssleeping**	Level of pain hindering the patient's ability to sleep during the first/ second/ third day after the shaping treatment	0 min – 10 max
	39, 40, 41	**/ D1Ssocial_relat / D2Ssocial_relat / D3Ssocial_relat**	Level of pain hindering the patient's ability to engage in social relations during the first/ second/ third day after the shaping treatment	0 min – 10 max
	42, 43, 44	**/ D1Soqol** **/ D2Soqol** **/ D3Soqol**	Level of pain hindering the patient's overall quality of life during the first/ second/ third day after the shaping treatment	0 min – 10 max
	45, 46, 47	**/ D1Sai** **/ D2Sai** **/ D3Sai**	Number of analgesics consumed during the first/ second/ third day after the shaping treatment	№
Levels of pain,	48, 49, 50	**/ D1Fmean** **/ D2Fmean** **/ D3Fmean**	Level of mean pain during the first/ second/ third day following the filling treatment	0 min – 10 max

influence on patients' life and analgesic intake after Filling treatment	51, 52, 53	**/ D1Fmax / D2Fmax /D3Fmax**	Level of max pain during the first/ second/ third day following the filling treatment	0 min – 10 max
	54, 55, 56	**/ D1Feating / D2Feating / D3Feating**	Level of pain hindering the patient's ability to eat during the first/ second/ third day following the filling treatment	0 min – 10 max
	57, 58, 59	**/ D1Fdaily_funct / D2Fdaily_funct / D3Fdaily_funct**	Level of pain hindering the patient's ability to perform daily functions during the first/ second/ third day following the filling treatment	0 min – 10 max
	60, 61, 62	**/ D1Fspeaking / D2Fspeaking / D3Fspeaking**	Level of pain hindering the patient's ability to speak during the first/ second/ third day following the filling treatment	0 min – 10 max
	63, 64, 65	**/ D1Fsleeping / D2Fsleeping / D3Fsleeping**	Level of pain hindering the patient's ability to sleep during the first/ second/ third day following the filling treatment	0 min – 10 max
	66,	**/**	Level of pain hindering the	0 min – 10 max

	67, 68	**D1Fsocial_relat / D2Fsocial_relat / D3Fsocial_relat**	patient’s ability to engage in social relations during the first/ second/ third day following the filling treatment	
	69, 70, 71	**/ D1Foqol / D2Foqol / D3Foqol**	Level of pain hindering the patient’s overall quality of life during the first/ second/ third day following the filling treatment	0 min – 10 max
	72, 73, 74	**/ D1Fai / D2Fai / D3Fai**	Number of analgesics consumed during the first/ second/ third day following the filling treatment	№

*LEO - lesion of endodontic origin; **AAE – American Association of Endodontics

Before proceeding with data analysis, a descriptive overview was established. The data under consideration fall into the following categories:

-*categorical* (age, proximal contacts, pulp tissue conditions, periodontal tissue conditions of chronic periodontitis, AAE difficulty);

-*qualitative* (binary - gender, tooth type, occlusal adjustments, occlusion, periodontal tissue conditions of acute periodontitis (percussion);

nominative - obturation technique, pulp tissue diagnosis);

-*quantitative* (mean and max pain, pain while eating/daily function/ speaking/ sleeping/ social relation/ overall influence on quality of life (QoL) / analgesic intake at Baseline, Day 1, 2, 3 after Shaping and following Filling).

In total 80 patients were selected for the study. The randomization groups were:

1) patients with root canals filled using the single cone technique and a bioceramic sealer (BC_c), n=20;
2) patients with root canals filled using the warm vertical technique and a bioceramic sealer (BC_w), n=20;
3) patients with root canals filled using the single cone technique and a resin-based sealer (AH_c), n=20;
4) patients with root canals filled using the warm vertical technique and a resin-based sealer (AH_w), n=20.

All statistical analyses were conducted using STATA BE 17 (64-bit), 2021.

```
  ___  ____  ____  ____  ____ ®
 /__    /   ____/   /   ____/      17.0
___/   /   /___/   /   /___/       BE—Basic Edition

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The distribution and description of data regarding the pre-operative clinical status of patients and teeth prior to the treatment are detailed through the subsequent commands:

```
. summarize age gender ttype prox_cont occl_adj occl pulp acute_perio chron_perio AAE
```

Variable	Obs	Mean	Std. dev.	Min	Max
age	80	3.9375	.9459273	3	6
gender	80	1.4625	.5017375	1	2
ttype	80	1.8125	.3927749	1	2
prox_cont	80	1.3375	.6353261	0	2
occl_adj	80	.1125	.3179742	0	1
occl	80	.8875	.3179742	0	1
pulp	80	2.3	.7008133	1	3
acute_perio	80	.4875	.5029973	0	1
chron_perio	80	.6125	.8189798	0	2
AAE	80	1.6125	.7376622	1	3

```
. tabulate age
```

age	Freq.	Percent	Cum.
3	32	40.00	40.00
4	27	33.75	73.75
5	15	18.75	92.50
6	6	7.50	100.00
Total	80	100.00	

```
. tabulate gender
```

1M, 2F	Freq.	Percent	Cum.
1	43	53.75	53.75
2	37	46.25	100.00
Total	80	100.00	

```
. tabulate ttype
```

1single, 2multi	Freq.	Percent	Cum.
1	15	18.75	18.75
2	65	81.25	100.00
Total	80	100.00	

```
. tabulate prox_cont
```

0no, 1contact, 2contacts	Freq.	Percent	Cum.
0	7	8.75	8.75
1	39	48.75	57.50
2	34	42.50	100.00
Total	80	100.00	

```
. tabulate occl_adj

   0no, 1yes |      Freq.     Percent        Cum.
-------------+-----------------------------------
           0 |         71       88.75       88.75
           1 |          9       11.25      100.00
-------------+-----------------------------------
       Total |         80      100.00

. tabulate occl

   0no, 1yes |      Freq.     Percent        Cum.
-------------+-----------------------------------
           0 |          9       11.25       11.25
           1 |         71       88.75      100.00
-------------+-----------------------------------
       Total |         80      100.00

. tabulate pulp

1asympt_irr |
   ev_pulp, |
2sympt_irre |
    v_pulp, |
3pulp_necro |      Freq.     Percent        Cum.
-------------+-----------------------------------
           1 |         11       13.75       13.75
           2 |         34       42.50       56.25
           3 |         35       43.75      100.00
-------------+-----------------------------------
       Total |         80      100.00


. tabulate acute_perio

 0 -perc, 1 |
      +perc |      Freq.     Percent        Cum.
-------------+-----------------------------------
           0 |         41       51.25       51.25
           1 |         39       48.75      100.00
-------------+-----------------------------------
       Total |         80      100.00

. tabulate chron_perio

0 no LEO, 1 |
 LEO<1mm, 2 |
    LEO>2mm |      Freq.     Percent        Cum.
-------------+-----------------------------------
           0 |         48       60.00       60.00
           1 |         15       18.75       78.75
           2 |         17       21.25      100.00
-------------+-----------------------------------
       Total |         80      100.00

. tabulate AAE

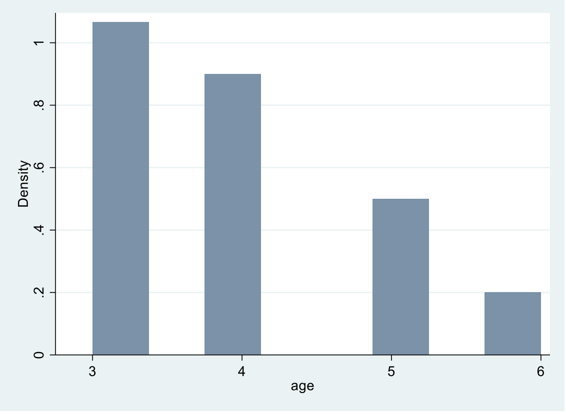
1min, 2mod, |
      3high |      Freq.     Percent        Cum.
-------------+-----------------------------------
           1 |         43       53.75       53.75
           2 |         25       31.25       85.00
           3 |         12       15.00      100.00
-------------+-----------------------------------
       Total |         80      100.00

.
```

Based on the results of the aforementioned commands, the following observations can be made regarding the listed variables:

/ Age: The sample comprises four age groups, with a median age of 3.935. Patient ages span from 30 to 69 years. 40% of the patients are between 30 to 39 years old. The smallest group consists of those aged 60 to 69 years, representing 7.5% of the total. (Pic.1).

Pic.1 Age distribution graph



/ *gender:* The sample is dominated by gender 1 (male), with a coefficient of 1.462 (53.75 %). Gender 2 (female) has a lower frequency (46.25 %).

/ *ttype:* Most of the teeth in the selection belong to characteristic 2 (multi-rooted). The median is 2, indicating that the type of this tooth predominates (81.25 %).

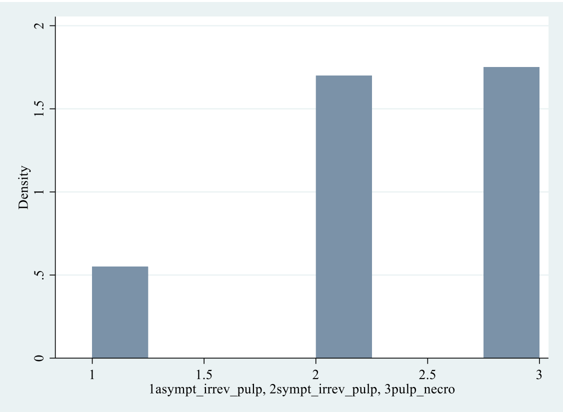
/ *prox_cont:* most of the teeth in the sample have 1 (48.75 %) or 2 (42.50 %) contacts. The average value is 1.337.

/ *occl_adj:* Most of the patients in the sample did not receive occlusion correction (value 0, 88.75%). The mean value is 0.1125, which indicates a small number of patients who received occlusion correction (11.25 %).

/ *occl:* Majority of the cases (88.75%) results that the teeth in the sample have an antagonist (value 1), indicating the prevalence of this characteristic.

/ *pulp:* The diagnosis of the pulp is represented by the cases of asymptomatic (13.75 %) and symptomatic irreversible pulpitis (42.5 %), pulp necrosis (43.75 %) that values from 1 to 3. The mean value is 2.3, indicating the average condition of the pulp in the sample (Pic.2).

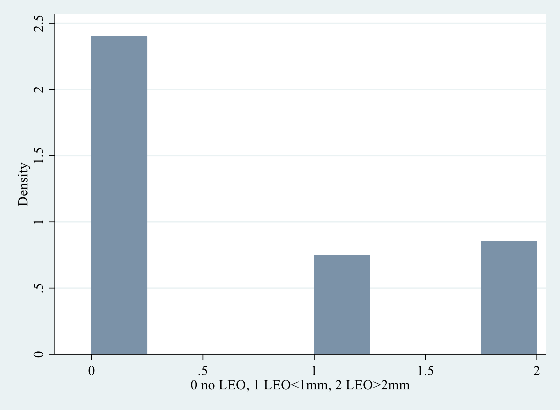
Pic. 2 Pulp diagnosis distribution



/ *acute_perio:* Almost half of (48.75 %) the patients in the sample have painful percussion (value 1).

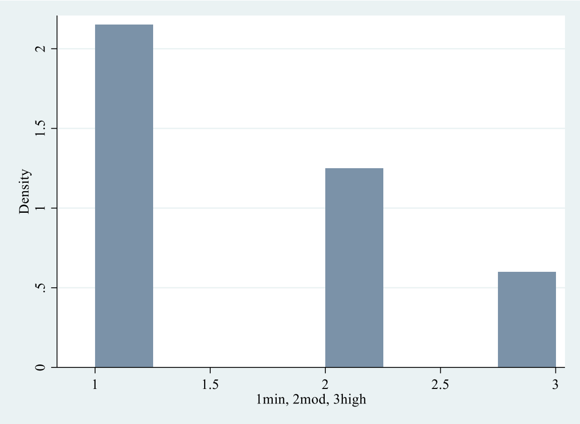
/ *chronic_perio:* Most patients in the sample have no periodontal complications such as lesion of endodontic origin (60.0 %). The mean value is 0.6125, indicating the average frequency of this condition (Pic.3).

Pic.3 Distribution of periodontal status



/ *AAE:* Case Difficulty is represented by values from 1 to 3, from minimal (53.75 %) to high level (15.0 %). The average difficulty is approximately 1.613, indicating the average level of difficulty of the cases (Pic.4).

Pic. 4 Case difficulty distribution



The distribution and description of pain variables prior to treatment are illustrated by the subsequent commands:

```
. summarize BASEmean BASEmax BASEeating BASEdaily_funct BASEspeaking BASEsleeping BASEsocial_relat BASEqol BASEai
```

Variable	Obs	Mean	Std. dev.	Min	Max
BASEmean	80	3.2375	2.838451	0	10
BASEmax	80	3.9375	3.380299	0	10
BASEeating	80	2.9625	3.231349	0	10
BASEdaily_~t	80	2.075	2.699156	0	9
BASEspeaking	80	1.3875	2.498069	0	8
BASEsleeping	80	2.075	2.889418	0	10
BASEsocial~t	80	1.4875	2.545752	0	9
BASEqol	80	2.1375	2.717704	0	9
BASEai	80	1.2875	2.069634	0	8

.

. tabulate BASEmean

BASEmean	Freq.	Percent	Cum.
0	25	31.25	31.25
1	2	2.50	33.75
2	4	5.00	38.75
3	15	18.75	57.50
4	9	11.25	68.75
5	8	10.00	78.75
6	1	1.25	80.00
7	9	11.25	91.25
8	5	6.25	97.50
9	1	1.25	98.75
10	1	1.25	100.00
Total	80	100.00	

. tabulate BASEmax

BASEmax	Freq.	Percent	Cum.
0	25	31.25	31.25
1	4	5.00	36.25
2	1	1.25	37.50
3	6	7.50	45.00
4	9	11.25	56.25
5	4	5.00	61.25
6	10	12.50	73.75
7	4	5.00	78.75
8	9	11.25	90.00
9	5	6.25	96.25
10	3	3.75	100.00
Total	80	100.00	

. tabulate BASEeating

BASEeating	Freq.	Percent	Cum.
0	34	42.50	42.50
2	11	13.75	56.25
3	4	5.00	61.25
4	9	11.25	72.50
5	1	1.25	73.75
6	4	5.00	78.75
7	4	5.00	83.75
8	9	11.25	95.00
9	2	2.50	97.50
10	2	2.50	100.00
Total	80	100.00	

. tabulate BASEdaily_funct

BASEdaily_funct	Freq.	Percent	Cum.
0	41	51.25	51.25
1	3	3.75	55.00
2	9	11.25	66.25
3	8	10.00	76.25
4	2	2.50	78.75
5	4	5.00	83.75
6	4	5.00	88.75
7	4	5.00	93.75
8	4	5.00	98.75
9	1	1.25	100.00
Total	80	100.00	

. tabulate BASEspeaking

BASEspeaking	Freq.	Percent	Cum.
0	56	70.00	70.00
1	2	2.50	72.50
2	5	6.25	78.75
3	3	3.75	82.50
5	4	5.00	87.50
6	4	5.00	92.50
7	2	2.50	95.00
8	4	5.00	100.00
Total	80	100.00	

. tabulate BASEsleeping

BASEsleeping	Freq.	Percent	Cum.
0	43	53.75	53.75
1	2	2.50	56.25
2	10	12.50	68.75
3	6	7.50	76.25
4	3	3.75	80.00
5	4	5.00	85.00
6	2	2.50	87.50
7	4	5.00	92.50
8	3	3.75	96.25
10	3	3.75	100.00
Total	80	100.00	

. tabulate BASEsocial_relat

BASEsocial_relat	Freq.	Percent	Cum.
0	52	65.00	65.00
1	1	1.25	66.25
2	11	13.75	80.00
3	3	3.75	83.75
4	1	1.25	85.00
5	4	5.00	90.00
6	1	1.25	91.25
8	6	7.50	98.75
9	1	1.25	100.00
Total	80	100.00	

. tabulate BASEqol

BASEqol	Freq.	Percent	Cum.
0	42	52.50	52.50
1	1	1.25	53.75
2	7	8.75	62.50
3	9	11.25	73.75
4	1	1.25	75.00
5	10	12.50	87.50
6	2	2.50	90.00
7	3	3.75	93.75
8	3	3.75	97.50
9	2	2.50	100.00
Total	80	100.00	

. tabulate BASEai

BASEai	Freq.	Percent	Cum.
0	51	63.75	63.75
1	3	3.75	67.50
2	10	12.50	80.00
3	2	2.50	82.50
4	4	5.00	87.50
5	5	6.25	93.75
6	3	3.75	97.50
7	1	1.25	98.75
8	1	1.25	100.00
Total	80	100.00	

.

/ *BASEmax:* The mean maximal pain before the treatment is approximately 3.938, with a median of 4. This provides an estimate of the patients' baseline pain level.

/ *BASEqol:* The mean impact on quality of life before treatment is about 2.138, with a median of 0. This indicates the low impact of the disease on the patients' quality of life.

/ *BASEai:* On average, patients took about 1,288 pain medications before treatment, with a median of 0. This indicates low analgesic intake before the treatment.

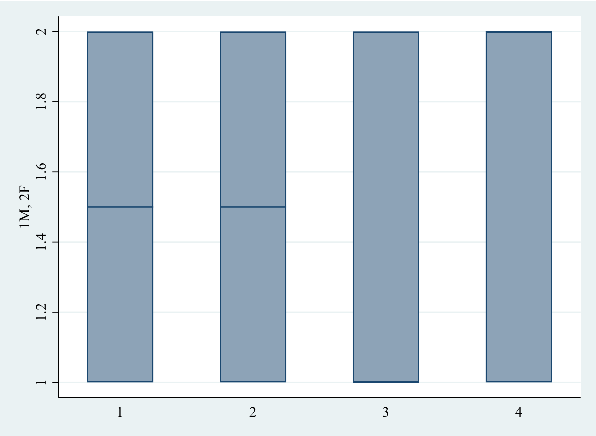
The next table (Tab.2) of distributions between obturation groups represents the absolute numbers and proportions of the main pre-operative variables (except quantitative variables):

Tab. 2 Pre-operative variable distribution among the obturation groups

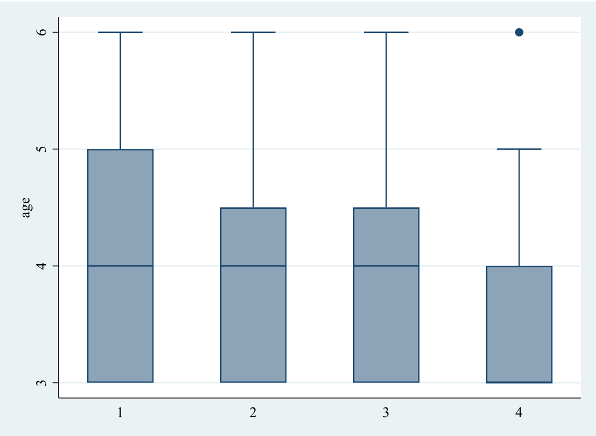
		BCc		BCw		AHc		AHw		p-value
		num	%	num	%	num	%	num	%	n
gender	**1 (m)**	10	50	10	50	14	70	9	45	0,712
	2 (f)	10	50	10	50	6	30	11	55	0,661
p_value		1		1		0,736		0,655		
age	**3**	6	18,75	6	22,222	6	18,75	2	18,75	0,522
	4	9	28,125	6	22,222	4	28,125	1	28,125	0,801
	5	6	18,75	9	33,333	3	18,75	2	18,75	0,506
	6	11	34,375	6	22,222	2	34,375	1	34,375	0,881
p_value		0,494		0,0786		0,112		0,00613		
ttype	**1 (single)**	0	0	6	30	4	20	5	25	0,819
	2 (multi)	20	100	14	70	16	80	15	75	0,735
prox_cont	**0 (no)**	0	0	2	10	2	10	3	15	0,867
	1 (contact)	20	100	1	5	13	65	5	25	6E-05
	2 (contacts)	0	0	17	85	5	25	12	60	0,0405
occl_adj	**0 (no)**	16	80	20	100	15	75	20	100	0,76
	1 (yes)	4	20	0	0	5	25	0	0	0,739
occl	**0 (no)**	0	0	2	10	2	10	5	25	0,368
	1 (yes)	20	100	18	90	18	90	15	75	0,869
pulp	**1 (asympt_irrev_pulp)**	2	10	4	20	0	0	5	25	0,529
	2 (sympt_irrev_pulp)	12	60	7	35	12	60	3	15	0,0819
	3 (pulp_necro)	6	30	9	45	8	40	12	60	0,543
p_value		0,0224		0,387		0,371		0,0351		
acute_perio	**0 (-perc)**	6	30	9	45	9	45	17	85	0,0892
	1 (+perc)	14	70	11	55	11	55	3	15	0,077
p_value		0,0736		0,655		0,655		0,00175		
chron_perio	**0 (no LEO)**	14	70	13	65	9	45	12	60	0,761
	1 (LEO 1-2 mm)	0	0	7	35	5	25	3	15	0,449
	2 (LEO>2mm)	6	30	0	0	6	30	5	25	0,943
p_value		0,0736		0,18		0,522		0,0351		
AAE	**1 (min)**	11	55	16	80	12	60	4	20	0,0734
	2 (mod)	9	45	4	20	6	30	6	30	0,564
	3 (high)	0	0	0	0	2	10	10	50	0,0209
p_value		0,655		0,00729		0,0224		0,247		

A significant level of statistical significance is evident in the following scenarios: presence of 1 (P=0.000006) or 2 (P=0.0405) proximal contacts, and a high level of AAE difficulty for the tooth (P=0.0209). Additionally, p-value analysis revealed a statistically significant difference among the obturation groups, favoring the bioceramic warm group (P=0.00729) and the resin cold group (P=0.0224). The remaining data did not demonstrate a significant difference in the distributions of patients across different genders, ages, tooth types, and other clinical pre-operative characteristics among the four filling groups (Pictures 5-9).

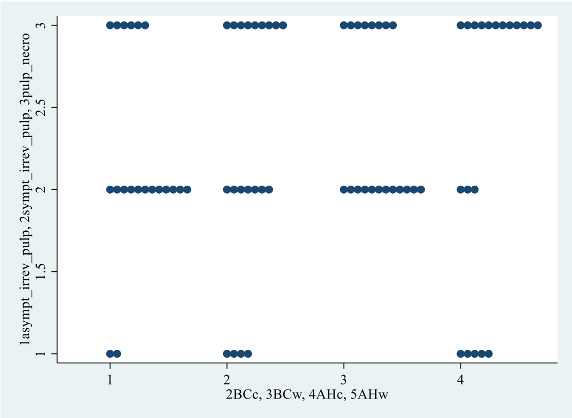
Pic.5 Distribution of gender in obturation groups



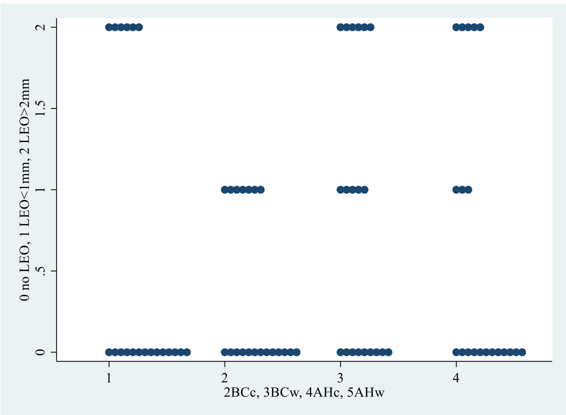
Pic.6 Distribution of age in obturation groups



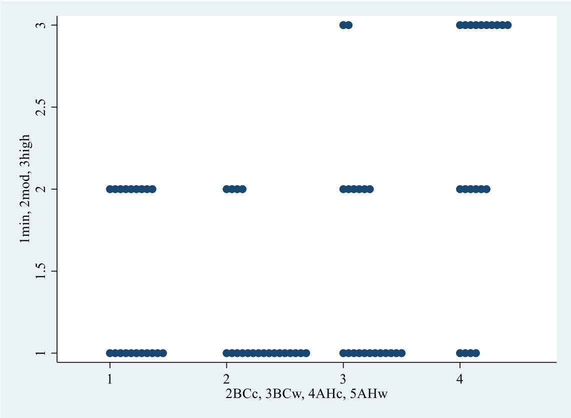
Pic. 7 Distribution of pulp diagnosis in obturation groups



Pic. 8 Distribution of periodontal diagnosis in obturation groups



Pic. 9 Distribution of case difficulty in obturation groups



To prepare for subsequent analyses described in the following sections, we conducted several tests to assess the normality of the distribution of quantitative variables: the Shapiro-Francia test, Shapiro-Wilk test, and the Skewness and Kurtosis test (Figures 1-3)

Fig.1. Testing the distribution normality of the collected data on pain levels with the Shapiro-Francia test.

```
. sfrancia BASEmean BASEmax BASEeating BASEdaily_funct BASEspeaking BASEsleeping BASEsocial_relat BASEqo
> l BASEai D1Smean D1Smax D1Seating D1Sdaily_funct D1Sspeaking D1Ssleeping D1Ssocial_relat D1Soqol D1Sai
>  D2Smean D2Smax D2Seating D2Sdaily_funct D2Sspeaking D2Ssleeping D2Ssocial_relat D2Soqol D2Sai D3Smean
>  D3Smax D3Seating D3Sdaily_funct D3Sspeaking D3Ssleeping D3Ssocial_relat D3Soqol D3Sai D1Fmean D1Fmax
> D1Feating D1Fdaily_funct D1Fspeaking D1Fsleeping D1Fsocial_relat D1Foqol D1Fai D2Fmean D2Fmax D2Featin
> g D2Fdaily_funct D2Fspeaking D2Fsleeping D2Fsocial_relat D2Foqol D2Fai D3Fmean D3Fmax D3Feating D3Fdai
> ly_funct D3Fspeaking D3Fsleeping D3Fsocial_relat D3Foqol D3Fai
```

Shapiro-Francia W' test for normal data

Variable	Obs	W'	V'	z	Prob>z
BASEmean	80	0.99204	0.604	-0.983	0.83728
BASEmax	80	0.97832	1.644	0.968	0.16645
BASEeating	80	0.97600	1.820	1.166	0.12175
BASEdaily_~t	80	0.96501	2.653	1.900	0.02869
BASEspeaking	80	0.94610	4.086	2.742	0.00305
BASEsleeping	80	0.95648	3.300	2.326	0.01001
BASEsocial~t	80	0.92351	5.800	3.424	0.00031
BASEqol	80	0.98499	1.138	0.252	0.40060
BASEai	80	0.96042	3.001	2.141	0.01614
D1Smean	80	0.98333	1.264	0.456	0.32410
D1Smax	80	0.98471	1.159	0.288	0.38657
D1Seating	80	0.97156	2.156	1.497	0.06721
D1Sdaily_f~t	80	0.93752	4.737	3.030	0.00122
D1Sspeaking	80	0.91868	6.165	3.544	0.00020
D1Ssleeping	80	0.83940	12.177	4.869	0.00001
D1Ssocial_~t	80	0.83138	12.784	4.964	0.00001
D1Soqol	80	0.91874	6.161	3.542	0.00020
D1Sai	80	0.71662	21.486	5.976	0.00001
D2Smean	80	0.92049	6.029	3.500	0.00023
D2Smax	80	0.92860	5.413	3.290	0.00050
D2Seating	80	0.86362	10.340	4.551	0.00001
D2Sdaily_f~t	80	0.76626	17.722	5.600	0.00001
D2Sspeaking	80	0.77234	17.260	5.549	0.00001
D2Ssleeping	80	0.83899	12.207	4.874	0.00001
D2Ssocial_~t	80	0.71498	21.610	5.987	0.00001
D2Soqol	80	0.83420	12.571	4.931	0.00001
D2Sai	80	0.78745	16.115	5.415	0.00001
D3Smean	80	0.89065	8.291	4.120	0.00002
D3Smax	80	0.89276	8.130	4.082	0.00002
D3Seating	80	0.84066	12.081	4.854	0.00001
D3Sdaily_f~t	80	0.78553	16.261	5.433	0.00001
D3Sspeaking	80	0.73286	20.254	5.861	0.00001
D3Ssleeping	80	0.94732	3.994	2.698	0.00349
D3Ssocial_~t	80	0.66671	25.269	6.292	0.00001
D3Soqol	80	0.80162	15.041	5.281	0.00001
D3Sai	80	0.96708	2.496	1.782	0.03737
D1Fmean	80	0.85851	10.727	4.622	0.00001
D1Fmax	80	0.93983	4.562	2.957	0.00155
D1Feating	80	0.78141	16.573	5.470	0.00001
D1Fdaily_f~t	80	0.82454	13.303	5.042	0.00001
D1Fspeaking	80	0.86719	10.070	4.499	0.00001
D1Fsleeping	80	0.87301	9.628	4.412	0.00001
D1Fsocial_~t	80	0.88136	8.995	4.279	0.00001
D1Foqol	80	0.77472	17.081	5.529	0.00001
D1Fai	80	0.97948	1.556	0.861	0.19454
D2Fmean	80	0.68124	24.168	6.205	0.00001
D2Fmax	80	0.85046	11.338	4.730	0.00001
D2Feating	80	0.80691	14.640	5.228	0.00001
D2Fdaily_f~t	80	0.74327	19.465	5.783	0.00001
D2Fspeaking	80	0.72587	20.784	5.911	0.00001
D2Fsleeping	80	0.94278	4.338	2.859	0.00213
D2Fsocial_~t	80	0.87417	9.540	4.394	0.00001
D2Foqol	80	0.81461	14.056	5.149	0.00001
D2Fai	80	0.94210	4.390	2.882	0.00198
D3Fmean	80	0.65917	25.841	6.335	0.00001
D3Fmax	80	0.73172	20.340	5.869	0.00001
D3Feating	80	0.76848	17.553	5.582	0.00001
D3Fdaily_f~t	80	0.68414	23.948	6.187	0.00001
D3Fspeaking	80	0.54917	34.181	6.880	0.00001
D3Fsleeping	80	0.90737	7.023	3.797	0.00007
D3Fsocial_~t	80	0.70419	22.427	6.059	0.00001
D3Foqol	80	0.71189	21.844	6.008	0.00001
D3Fai	80	0.94445	4.212	2.801	0.00255

Given that the p-value for most of the variables is less than 0.05 (as shown in Fig.1), we can reject the null hypothesis of the test. This provides sufficient evidence to assert that the distribution of these variables is not normal. However, a few variables exhibited a p-value greater than 0.05, suggesting that their distributions might be consistent with normality. These variables include: (/ BASEmean (P=0.837), / BASEmax (P=0.166), / BASEeating (P=0.122), / BASEqol (P=0.4), / D1Smean (P=0.324), / D1Smax (P=0.386), / D1Seating (P=0.067), / D1Fai (P=0.194)). For these reasons we double-checked the normality tests using Shapiro-Wilk's test (Pic.B), Skewness and Kurtosis test (Pic.C). The Shapiro-Wilk's test confirmed that there is sufficient evidence to conclude that all the variables are not normally distributed (p-value <0.05): / BASEmean (P=0.001), / BASEmax (P=0.001), / BASEeating (P=0.00), / BASEqol (P=0.00), / D1Smean (P=0.002), / D1Smax (P=0.003), / D1Seating (P=0.00), / D1Fai (P=0.00). Skewness and Kurtosis test (Pic.C) test confirmed that there is sufficient evidence to conclude that all the variables are not normally distributed (p-value <0.05): / BASEmean (P=0.0139), / BASEmax (P=0.00), / BASEeating (P=0.0025), / BASEqol (P=0.0077), / D1Smean (P=0.0287), / D1Smax (P=0.0016), / D1Seating (P=0.005), / D1Fai (P=0.00).

Fig.2 The Shapiro-Wilk's test

```
. swilk BASEmean BASEmax BASEeating BASEdaily_funct BASEspeaking BASEsleeping BASEsocial_relat BASEqol B
> ASEai D1Smean D1Smax D1Seating D1Sdaily_funct D1Sspeaking D1Ssleeping D1Ssocial_relat D1Soqol D1Sai D2
> Smean D2Smax D2Seating D2Sdaily_funct D2Sspeaking D2Ssleeping D2Ssocial_relat D2Soqol D2Sai D3Smean D3
> Smax D3Seating D3Sdaily_funct D3Sspeaking D3Ssleeping D3Ssocial_relat D3Soqol D3Sai D1Fmean D1Fmax D1F
> eating D1Fdaily_funct D1Fspeaking D1Fsleeping D1Fsocial_relat D1Foqol D1Fai D2Fmean D2Fmax D2Feating D
> 2Fdaily_funct D2Fspeaking D2Fsleeping D2Fsocial_relat D2Foqol D2Fai D3Fmean D3Fmax D3Feating D3Fdaily_
> funct D3Fspeaking D3Fsleeping D3Fsocial_relat D3Foqol D3Fai
```

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
BASEmean	80	0.94136	4.025	3.051	0.00114
BASEmax	80	0.94209	3.975	3.024	0.00125
BASEeating	80	0.90795	6.318	4.039	0.00003
BASEdaily_~t	80	0.88480	7.908	4.531	0.00000
BASEspeaking	80	0.84781	10.446	5.141	0.00000
BASEsleeping	80	0.88190	8.106	4.585	0.00000
BASEsocial~t	80	0.82208	12.212	5.483	0.00000
BASEqol	80	0.89873	6.951	4.248	0.00001
BASEai	80	0.84578	10.586	5.170	0.00000
D1Smean	80	0.94684	3.649	2.836	0.00228
D1Smax	80	0.95049	3.398	2.680	0.00368
D1Seating	80	0.93465	4.486	3.289	0.00050
D1Sdaily_f~t	80	0.86496	9.269	4.879	0.00000
D1Sspeaking	80	0.82296	12.152	5.472	0.00000
D1Ssleeping	80	0.73348	18.294	6.369	0.00000
D1Ssocial_~t	80	0.70013	20.583	6.627	0.00000
D1Soqol	80	0.81882	12.436	5.523	0.00000
D1Sai	80	0.63786	24.857	7.040	0.00000
D2Smean	80	0.83157	11.561	5.363	0.00000
D2Smax	80	0.86859	9.020	4.819	0.00000
D2Seating	80	0.79891	13.803	5.751	0.00000
D2Sdaily_f~t	80	0.63428	25.103	7.062	0.00000
D2Sspeaking	80	0.61916	26.141	7.151	0.00000
D2Ssleeping	80	0.67611	22.232	6.796	0.00000
D2Ssocial_~t	80	0.56853	29.616	7.424	0.00000
D2Soqol	80	0.71907	19.283	6.484	0.00000
D2Sai	80	0.63297	25.193	7.070	0.00000
D3Smean	80	0.78877	14.499	5.859	0.00000
D3Smax	80	0.78936	14.458	5.853	0.00000
D3Seating	80	0.72517	18.864	6.436	0.00000
D3Sdaily_f~t	80	0.63920	24.765	7.032	0.00000
D3Sspeaking	80	0.56663	29.747	7.434	0.00000
D3Ssleeping	80	0.66189	23.208	6.890	0.00000
D3Ssocial_~t	80	0.51553	33.254	7.678	0.00000
D3Soqol	80	0.64725	24.213	6.983	0.00000
D3Sai	80	0.71583	19.506	6.509	0.00000
D1Fmean	80	0.79703	13.932	5.772	0.00000
D1Fmax	80	0.88030	8.216	4.615	0.00000
D1Feating	80	0.69599	20.867	6.657	0.00000
D1Fdaily_f~t	80	0.65672	23.563	6.923	0.00000
D1Fspeaking	80	0.67537	22.282	6.801	0.00000
D1Fsleeping	80	0.54052	31.539	7.562	0.00000
D1Fsocial_~t	80	0.63809	24.841	7.039	0.00000
D1Foqol	80	0.59370	27.888	7.292	0.00000
D1Fai	80	0.76465	16.155	6.096	0.00000
D2Fmean	80	0.57424	29.224	7.395	0.00000
D2Fmax	80	0.71970	19.239	6.479	0.00000
D2Feating	80	0.64183	24.585	7.016	0.00000
D2Fdaily_f~t	80	0.55987	30.210	7.468	0.00000
D2Fspeaking	80	0.56212	30.056	7.456	0.00000
D2Fsleeping	80	0.57185	29.388	7.407	0.00000
D2Fsocial_~t	80	0.60296	27.252	7.242	0.00000
D2Foqol	80	0.57279	29.324	7.402	0.00000
D2Fai	80	0.49862	34.415	7.753	0.00000
D3Fmean	80	0.53417	31.974	7.592	0.00000
D3Fmax	80	0.58809	28.274	7.322	0.00000
D3Feating	80	0.61322	26.548	7.185	0.00000
D3Fdaily_f~t	80	0.43761	38.602	8.005	0.00000
D3Fspeaking	80	0.43621	38.699	8.010	0.00000
D3Fsleeping	80	0.54871	30.976	7.523	0.00000
D3Fsocial_~t	80	0.45813	37.194	7.923	0.00000
D3Foqol	80	0.45541	37.381	7.934	0.00000
D3Fai	80	0.58265	28.647	7.351	0.00000

Fig.3. The Skewness and Kurtotis test

```
. sktest BASEmean BASEmax BASEeating BASEdaily_funct BASEspeaking BASEsleeping BASEsocial_relat BASEqol
> BASEai D1Smean D1Smax D1Seating D1Sdaily_funct D1Sspeaking D1Ssleeping D1Ssocial_relat D1Soqol D1Sai D
> 2Smean D2Smax D2Seating D2Sdaily_funct D2Sspeaking D2Ssleeping D2Ssocial_relat D2Soqol D2Sai D3Smean D
> 3Smax D3Seating D3Sdaily_funct D3Sspeaking D3Ssleeping D3Ssocial_relat D3Soqol D3Sai D1Fmean D1Fmax D1
> Feating D1Fdaily_funct D1Fspeaking D1Fsleeping D1Fsocial_relat D1Foqol D1Fai D2Fmean D2Fmax D2Feating
> D2Fdaily_funct D2Fspeaking D2Fsleeping D2Fsocial_relat D2Foqol D2Fai D3Fmean D3Fmax D3Feating D3Fdaily
> _funct D3Fspeaking D3Fsleeping D3Fsocial_relat D3Foqol D3Fai
```

Skewness and kurtosis tests for normality

				Joint test	
Variable	Obs	Pr(skewness)	Pr(kurtosis)	Adj chi2(2)	Prob>chi2
BASEmean	80	0.1300	0.0063	8.54	0.0139
BASEmax	80	0.5282	0.0000	37.99	0.0000
BASEeating	80	0.0137	0.0037	11.96	0.0025
BASEdaily_funct	80	0.0004	0.9453	10.72	0.0047
BASEspeaking	80	0.0000	0.0607	20.28	0.0000
BASEsleeping	80	0.0000	0.1905	15.09	0.0005
BASEsocial_relat	80	0.0000	0.0152	23.23	0.0000
BASEqol	80	0.0008	0.8207	9.73	0.0077
BASEai	80	0.0000	0.0531	19.15	0.0001
D1Smean	80	0.0796	0.0296	7.10	0.0287
D1Smax	80	0.1934	0.0002	12.92	0.0016
D1Seating	80	0.0078	0.0185	10.61	0.0050
D1Sdaily_funct	80	0.0000	0.2168	15.15	0.0005
D1Sspeaking	80	0.0000	0.0014	28.79	0.0000
D1Ssleeping	80	0.0000	0.0000	41.72	0.0000
D1Ssocial_relat	80	0.0000	0.0000	44.71	0.0000
D1Soqol	80	0.0000	0.0029	26.75	0.0000
D1Sai	80	0.0000	0.0000	80.54	0.0000
D2Smean	80	0.0000	0.0183	21.70	0.0000
D2Smax	80	0.0000	0.1725	16.30	0.0003
D2Seating	80	0.0000	0.0019	28.37	0.0000
D2Sdaily_funct	80	0.0000	0.0000	59.34	0.0000
D2Sspeaking	80	0.0000	0.0000	70.03	0.0000
D2Ssleeping	80	0.0000	0.0000	56.17	0.0000
D2Ssocial_relat	80	0.0000	0.0000	81.83	0.0000
D2Soqol	80	0.0000	0.0000	49.67	0.0000
D2Sai	80	0.0000	0.0000	80.47	0.0000
D3Smean	80	0.0000	0.0003	33.40	0.0000
D3Smax	80	0.0000	0.0007	31.85	0.0000
D3Seating	80	0.0000	0.0000	45.69	0.0000
D3Sdaily_funct	80	0.0000	0.0000	60.98	0.0000
D3Sspeaking	80	0.0000	0.0000	80.24	0.0000
D3Ssleeping	80	0.0000	0.0000	71.41	0.0000
D3Ssocial_relat	80	0.0000	0.0000	86.53	0.0000
D3Soqol	80	0.0000	0.0000	59.45	0.0000
D3Sai	80	0.0000	0.0000	56.63	0.0000
D1Fmean	80	0.0000	0.0000	44.31	0.0000
D1Fmax	80	0.0000	0.0008	24.94	0.0000
D1Feating	80	0.0000	0.0000	50.38	0.0000
D1Fdaily_funct	80	0.0000	0.0000	73.51	0.0000
D1Fspeaking	80	0.0000	0.0000	64.68	0.0000
D1Fsleeping	80	0.0000	0.0000	69.29	0.0000
D1Fsocial_relat	80	0.0000	0.0000	73.48	0.0000
D1Foqol	80	0.0000	0.0000	77.03	0.0000
D1Fai	80	0.0000	0.0000	45.23	0.0000
D2Fmean	80	0.0000	0.0000	82.90	0.0000
D2Fmax	80	0.0000	0.0000	59.52	0.0000
D2Feating	80	0.0000	0.0000	69.75	0.0000
D2Fdaily_funct	80	0.0000	0.0000	91.34	0.0000
D2Fspeaking	80	0.0000	0.0000	91.18	0.0000
D2Fsleeping	80	0.0000	0.0000	90.37	0.0000
D2Fsocial_relat	80	0.0000	0.0000	86.19	0.0000
D2Foqol	80	0.0000	0.0000	83.87	0.0000
D2Fai	80	0.0000	0.0000	101.80	0.0000
D3Fmean	80	0.0000	0.0000	90.84	0.0000
D3Fmax	80	0.0000	0.0000	80.91	0.0000
D3Feating	80	0.0000	0.0000	72.89	0.0000
D3Fdaily_funct	80	0.0000	0.0000	102.26	0.0000
D3Fspeaking	80	0.0000	0.0000	108.74	0.0000
D3Fsleeping	80	0.0000	0.0000	93.71	0.0000
D3Fsocial_relat	80	0.0000	0.0000	100.83	0.0000
D3Foqol	80	0.0000	0.0000	99.71	0.0000
D3Fai	80	0.0000	0.0000	90.32	0.0000

Based on the outcomes of the aforementioned tests, it's evident that the pain variables do not adhere to a normal distribution. This underscores the limitations of parametric tests and highlights the need to employ non-parametric tests for analyzing non-normally distributed quantitative data in subsequent sections.

II. EVALUATION OF THE POTENTIAL CORRELATION BETWEEN PRE-OPERATIVE VARIABLES AND PAIN LEVELS AT BASELINE (MAX, QOL, AI) PRIOR TO TREATMENT AND POST-SHAPING INTERVENTION (MAX, QOL, AI)

In this paragraph, for the comprehensive analysis we tested the potential correlation between ten independent pre-operative variables (/ age, / gender, / ttype, /prox_cont, / occl_adj, / occl, / pulp, / acute_perio, / chron_perio, / AAE) and their potential influence on main dependent continuous variables. Selected primary variables of qualitative data represented characteristics such as the peak pain level, the effect on overall quality of life, and analgesic intake at the baseline prior to treatment: BASEmax, / BASEqol, / BASEai) and on the first, second, third days after the shaping treatment (/ D1Smax, / D2Smax, / D3Smax; / D1Soqol, / D2Soqol, / D3Soqol; / D1Sai, / D2Sai, / D3Sai).

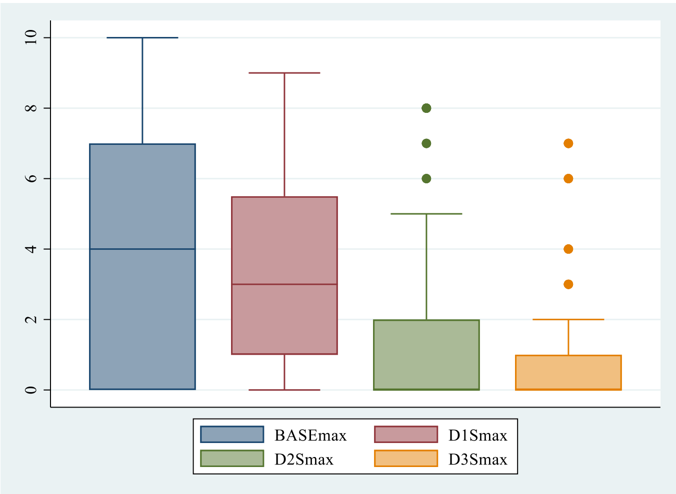
MAXIMAL PAIN LEVEL

First, we used the Spearman correlation coefficient test – a method for quantitatively assessing the statistical relationship between variables or events. We applied this to evaluate the peak pain level at various time points: at the baseline prior to treatment (/ BASEmax) and on the first, second, and third days post shaping treatment (/ D1Smax, / D2Smax, / D3Smax).

```
. spearman BASEmax D1Smax D2Smax D3Smax , star(.05)
(obs=80)

             |  BASEmax   D1Smax   D2Smax   D3Smax
-------------+------------------------------------
     BASEmax |   1.0000
      D1Smax |   0.4098*  1.0000
      D2Smax |   0.2047   0.7574*  1.0000
      D3Smax |   0.1327   0.5905*  0.8215*  1.0000
```

Pic.10 Pain level before and after Shaping treatment



The result (Pic.10) showed a statistically significant low positive correlation (0.4, P<0.05) between the pain level on the first day after shaping treatment and prior to that (/ D1Smax vs. / BASEmax), and also between pain on the third and first days (/ D3Smax vs. / D1Smax) (0.59, P<0.05). At the same time both the correlation magnitudes between / D2Smax and / D1Smax, as well as between the / D3Smax and / D2Smax pair indicate a high level of statistically significant positive correlation (0.76 and 0.82, respectively, $P<0.05$). The maximal pain level at the second and third days after shaping treatment has little if any (linear) correlation with the maximal pain level prior to treatment (/ D2Smax vs. / BASEmax; / D3Smax vs. / BASEmax), since their correlation magnitude equals less than 0.3 (0.2 and 0.13, respectively, $P>0.05$).

We also observed a continuous decrease in the maximal pain level (3.94; 3.4; 1.7; 0.96) following the shaping treatment. This decline is statistically significant, as confirmed by the Friedman test (P=0.00).

```
. sum BASEmax D1Smax D2Smax D3Smax
```

Variable	Obs	Mean	Std. dev.	Min	Max
BASEmax	80	3.9375	3.380299	0	10
D1Smax	80	3.4	2.74023	0	9
D2Smax	80	1.7	2.50771	0	8
D3Smax	80	.9625	1.892315	0	7

```
. friedman BASEmax D1Smax D2Smax D3Smax

Friedman = 164.5243
Kendall =    0.5206
P-value =    0.0000
```

At this point we performed the Spearman correlation coefficient test to analyze the correlation between maximal pain level prior to treatment (/ BASEmax) and the clinical pre-operative variables:

```
. spearman BASEmax D1Smax D2Smax D3Smax age gender ttype prox_cont occl_adj occl pulp acute_perio chron_perio AAE , star(.05)
(obs=80)
```

	BASEmax	D1Smax	D2Smax	D3Smax	age	gender	ttype	prox_c~t	occl_adj	occl	pulp	acute_~o	chron_~o
BASEmax	1.0000												
D1Smax	0.4098*	1.0000											
D2Smax	0.2047	0.7574*	1.0000										
D3Smax	0.1327	0.5905*	0.8215*	1.0000									
age	0.2987*	0.0605	0.0388	0.0092	1.0000								
gender	-0.1587	-0.1376	-0.0917	-0.0724	0.0466	1.0000							
ttype	0.0049	-0.0056	-0.0586	0.0428	-0.1330	-0.2609*	1.0000						
prox_cont	-0.0890	-0.1030	-0.0614	0.0513	-0.2366*	0.0792	-0.0880	1.0000					
occl_adj	0.1509	0.2553*	0.3421*	0.4463*	0.3258*	-0.0922	0.1710	-0.1621	1.0000				
occl	0.0471	-0.0156	-0.0611	0.1491	0.0290	0.0129	0.0317	0.2680*	0.1268	1.0000			
pulp	-0.0880	0.1603	0.1005	0.1059	0.0673	-0.1816	0.1137	-0.0261	0.3146*	0.0281	1.0000		
acute_perio	0.4903*	0.0328	-0.0327	-0.0187	-0.0086	-0.1022	-0.0440	-0.0856	0.0485	-0.0485	0.0178	1.0000	
chron_perio	0.0955	0.3452*	0.2808*	0.3605*	-0.0013	-0.0681	0.0301	-0.0049	0.4604*	-0.0274	0.5077*	0.1069	1.0000
AAE	-0.2667*	0.0518	0.1114	-0.0705	-0.0817	0.0838	0.2179	-0.2740*	-0.0580	-0.4119*	-0.0072	-0.2916*	-0.0343

	AAE
AAE	1.0000

/ BASEmax: The results revealed a low yet statistically significant positive correlation between the maximal pain before treatment (/ BASEmax) and percussion (/ acute_perio) (0.49, P<0.05), and the / age variable (0.3, P<0.05). There was a negative correlation observed with / AAE (-0.27, P<0.05). No statistically significant correlation was found between / BASEmax and the remaining variables (P>0.05).

For the maximal pain on the first day post-shaping treatment (/ D1Smax), there was a low but statistically significant positive correlation with occlusal adjustment (/ occl_adj) (0.26, P<0.05) and the LEO parameter (/ chron_perio) (0.35, P<0.05). No other significant correlations with / D1Smax were observed for the remaining variables (P>0.05).

Regarding the maximal pain on the second day post-shaping treatment (/ D2Smax), a statistically significant positive correlation was found with occlusal adjustment (/ occl_adj) (0.34, P<0.05) and the LEO parameter (/ chron_perio) (0.28, P<0.05). The other variables did not show a significant correlation with / D2Smax (P>0.05).

For the maximal pain on the third day post-shaping treatment (/ D3Smax), there was a statistically significant positive correlation with occlusal adjustment (/ occl_adj) (0.45, P<0.05) and the LEO parameter (/ chron_perio) (0.36, P<0.05). The remaining variables did not show any significant correlation with / D3Smax (P>0.05).

Building on the significant results from the Spearman test, we applied an ordered logistic regression to evaluate the influence of the identified independent pre-operative clinical variables on pain levels at different time-points (pre-treatment, and on days one, two, and three post-treatment).

```
. ologit BASEmax i.age i.acute_perio i.AAE, or

Iteration 0:   log likelihood = -168.78523
Iteration 1:   log likelihood = -152.47792
Iteration 2:   log likelihood = -152.14095
Iteration 3:   log likelihood = -152.14022
Iteration 4:   log likelihood = -152.14022

Ordered logistic regression                             Number of obs =     80
                                                        LR chi2(6)    =  33.29
                                                        Prob > chi2   = 0.0000
Log likelihood = -152.14022                             Pseudo R2     = 0.0986
```

BASEmax	Odds ratio	Std. err.	z	P>|z|	[95% conf.	interval]
age						
4	1.881317	.9484031	1.25	0.210	.7004181	5.053203
5	6.110991	3.800536	2.91	0.004	1.806068	20.67708
6	2.738428	2.208286	1.25	0.212	.5637507	13.30196
1.acute_perio	6.821628	3.210628	4.08	0.000	2.711854	17.1597
AAE						
2	.5081314	.2523075	-1.36	0.173	.1920085	1.344719
3	.3935742	.2730793	-1.34	0.179	.1010241	1.533304
/cut1	.1408912	.4594907			-.759694	1.041476
/cut2	.4591843	.4619154			-.4461533	1.364522
/cut3	.5407639	.4652344			-.3710787	1.452607
/cut4	1.017117	.4867445			.0631157	1.971119
/cut5	1.685988	.5205594			.6657101	2.706265
/cut6	1.969257	.5363867			.9179587	3.020556
/cut7	2.69867	.5723295			1.576924	3.820415
/cut8	3.025182	.5872672			1.874159	4.176204
/cut9	3.98339	.6466949			2.715891	5.250889
/cut10	5.044858	.7890837			3.498282	6.591433

Note: Estimates are transformed only in the first equation to odds ratios.

The result confirmed this model of ordered regression to be more precise than it could be without the predictors (Prob>chi2=0.00). According to the results of ordered regression, the influence of the age and positive percussion on the level of maximal pain before the treatment is significant ($p<0.05$) whereas the case difficulty level is not. ($P>0.05$).

For patients belonging to the 5th age group (relative to those in the 3rd age group), the likelihood of experiencing a higher pain level, when compared to all aggregated pain scores, is multiplied by 6.11 times, assuming that other variables in this model remain constant.

A positive percussion result amplifies the chance of enduring the maximum pain level, in relation to the collective pain scores, by 6.82 times, given that the remaining variables in this model are held constant.

```
. ologit D1Smax i.occl_adj i.chron_perio, or

Iteration 0:   log likelihood = -172.04437
Iteration 1:   log likelihood = -166.01822
Iteration 2:   log likelihood =  -165.9374
Iteration 3:   log likelihood = -165.93726
Iteration 4:   log likelihood = -165.93726

Ordered logistic regression                             Number of obs =     80
                                                        LR chi2(3)    =  12.21
                                                        Prob > chi2   = 0.0067
Log likelihood = -165.93726                             Pseudo R2     = 0.0355
```

D1Smax	Odds ratio	Std. err.	z	P>|z|	[95% conf.	interval]
1.occl_adj	2.840576	2.089429	1.42	0.156	.6718803	12.00939
chron_perio						
1	1.939466	.9754202	1.32	0.188	.7237447	5.197314
2	3.789197	2.093562	2.41	0.016	1.283073	11.19033
/cut1	-.8237141	.3068061			-1.425043	-.2223852
/cut2	-.4683634	.2959867			-1.048487	.1117598
/cut3	.1910213	.2952931			-.3877425	.7697852
/cut4	.8219077	.3121373			.2101298	1.433686
/cut5	1.294519	.3298502			.6480241	1.941013
/cut6	1.738987	.3502631			1.052484	2.42549
/cut7	2.128362	.3770798			1.389299	2.867424
/cut8	2.79222	.4454008			1.91925	3.665189
/cut9	5.229065	1.059945			3.15161	7.30652

Note: Estimates are transformed only in the first equation to odds ratios.

The result confirmed that this model of ordered regression is more precise than it could be without the predictors (Prob>chi2=0.0067). According to the results of ordered regression, the influence of LEO on the level of maximal pain on the first day after the treatment is significant (p<0.05), the occlusal adjustment is not (P>0.05). LEO more than 2 mm (compared to patients without LEO) increases the probability of having the highest level of pain compared to all combined pain scores in 3.79 times (P=0.016), providing that the rest variables of this model are permanent.

```
. ologit D2Smax i.occl_adj i.chron_perio, or

Iteration 0:   log likelihood = -123.86147
Iteration 1:   log likelihood = -118.56545
Iteration 2:   log likelihood = -118.36069
Iteration 3:   log likelihood = -118.36055
Iteration 4:   log likelihood = -118.36055

Ordered logistic regression                         Number of obs =     80
                                                    LR chi2(3)    =  11.00
                                                    Prob > chi2   = 0.0117
Log likelihood = -118.36055                         Pseudo R2     = 0.0444
```

D2Smax	Odds ratio	Std. err.	z	P>|z|	[95% conf.	interval]
1.occl_adj	4.832103	3.567683	2.13	0.033	1.136761	20.54013
chron_perio						
1	1.912601	1.07168	1.16	0.247	.6377844	5.735546
2	1.958076	1.192225	1.10	0.270	.5936816	6.458112
/cut1	.6459473	.3045267			.049086	1.242809
/cut2	1.049734	.3203407			.4218782	1.677591
/cut3	1.695758	.3539874			1.001955	2.38956
/cut4	1.84996	.3641888			1.136163	2.563757
/cut5	2.107192	.3839217			1.354719	2.859665
/cut6	2.666021	.4412305			1.801226	3.530817
/cut7	2.972945	.4816921			2.028846	3.917045
/cut8	3.372118	.5451034			2.303735	4.440501

Note: Estimates are transformed only in the first equation to odds ratios.

The results validate that this ordered regression model is more accurate than one without predictors (Prob>chi2=0.0067). Based on the outcomes of the ordered regression, the impact of LEO on the level of maximal pain on the first day post-treatment is statistically significant (p<0.05), whereas the influence of occlusal adjustment isn't (P>0.05). A LEO exceeding 2 mm, in comparison to patients without

LEO, multiplies the likelihood of experiencing the highest pain level relative to all aggregated pain scores by 3.79 times (P=0.016), assuming that other variables in this model remain constant.

```
. ologit D3Smax i.occl_adj i.chron_perio, or

Iteration 0:   log likelihood = -90.290528
Iteration 1:   log likelihood = -83.012681
Iteration 2:   log likelihood = -82.408352
Iteration 3:   log likelihood = -82.405695
Iteration 4:   log likelihood = -82.405694

Ordered logistic regression                          Number of obs =     80
                                                     LR chi2(3)    =  15.77
                                                     Prob > chi2   = 0.0013
Log likelihood = -82.405694                          Pseudo R2     = 0.0873

------------------------------------------------------------------------------
      D3Smax | Odds ratio   Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
  1.occl_adj |   5.693879   4.221688     2.35   0.019     1.331345    24.35151
             |
 chron_perio |
          1  |   2.077307   1.414668     1.07   0.283     .5467932    7.891837
          2  |   3.179278    2.10894     1.74   0.081     .8663496    11.66712
-------------+----------------------------------------------------------------
       /cut1 |   1.571558   .3871993                       .812661    2.330454
       /cut2 |   2.119582   .4261131                      1.284416    2.954748
       /cut3 |   2.570215   .4601326                      1.668372    3.472058
       /cut4 |   2.935735   .4961645                       1.96327    3.908199
       /cut5 |     3.4396   .5602894                      2.341453    4.537747
       /cut6 |   4.255948   .7080402                      2.868214    5.643681
------------------------------------------------------------------------------
Note: Estimates are transformed only in the first equation to odds ratios.
```

This ordered regression model is demonstrably more accurate than a model without the predictors (Prob>chi2=0.001). From the results of the ordered regression, it's evident that the effect of occlusal adjustment on the maximal pain level on the third day post-treatment is statistically significant (P=0.019), whereas the influence of LEO is not (P>0.05). For patients who underwent occlusal adjustment (as opposed to those who didn't require it), the likelihood of experiencing the highest pain level, relative to all aggregated pain scores, multiplies by 5.69 times, assuming all other variables in this model remain constant.

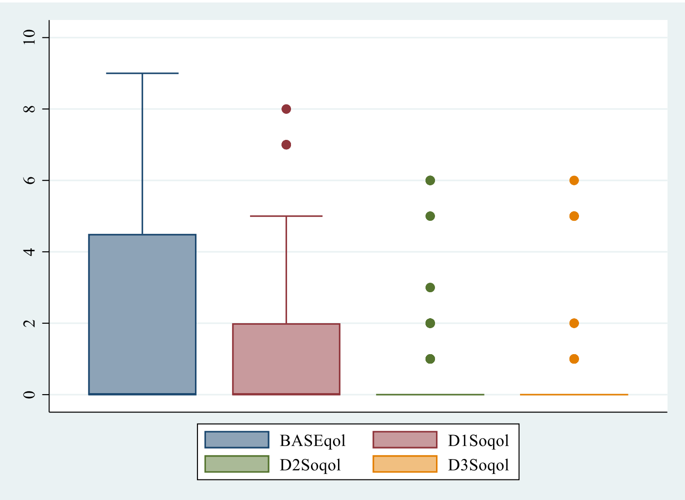
IMPACT ON THE OVERALL QUALITY OF LIFE

The same analytical approach was employed for variables highlighting the impact on patients' quality of life. Again we used the Spearman correlation coefficient test to quantitatively assess the relationship between variables at various time intervals: prior to treatment (denoted as / BASEqol) and on the first, second, and third days following the shaping procedure (represented by / D1Soqol, / D2Soqol, and / D3Soqol respectively).

```
. spearman BASEqol D1Soqol D2Soqol D3Soqol , star(.05)
(obs=80)

             |  BASEqol  D1Soqol  D2Soqol  D3Soqol
-------------+------------------------------------
     BASEqol |   1.0000
     D1Soqol |   0.2177   1.0000
     D2Soqol |   0.2007   0.7475*  1.0000
     D3Soqol |   0.2059   0.6233*  0.8303*  1.0000
```

Pic.11 Impact on quality of life before and after the shaping treatment



The result (Pic.11) revealed no statistically significant correlation between the impact on overall quality of life on the first, second and third day after shaping treatment and prior to it (/ D1Soqol, / D2Soqol, / D3Soqol vs. / BASEqol) (0.22, 0.2, 0.2, P>0.05). However, there are statistically significant correlations in the next pairs: / D2Soqol vs. / D1Soqol; / D3Soqol vs. / D1Soqol; / D3Soqol vs. / D2Soqol (high correlation, 0.75; moderate correlation, 0.62; high correlation, 0.83; P<0.05).

We also observed a consistent decline in the impact on overall quality of life scores (from 1.29 to 0.44 to 0.21 and finally to 0.12) following the shaping treatment. This decrease is statistically significant, as confirmed by the Friedman test (P=0.0066):

```
. sum BASEqol D1Soqol D2Soqol D3Soqol

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
     BASEqol |         80      2.1375    2.717704          0          9
     D1Soqol |         80      1.1875    2.000593          0          8
     D2Soqol |         80       .5625    1.367283          0          6
     D3Soqol |         80       .3875    1.195919          0          6
```

```
. friedman BASEqol D1Soqol D2Soqol D3Soqol

Friedman = 113.5491
Kendall =    0.3593
P-value =    0.0066
```

At this point, we used the Spearman correlation coefficient test to examine the relationship between the impact on overall quality of life prior to treatment (/ BASEqol) and various clinical pre-operative variables:

```
. spearman BASEqol D1Soqol D2Soqol D3Soqol age gender ttype prox_cont occl_adj occl pulp acute_perio chron_perio AAE , star(.05)
(obs=80)
```

	BASEqol	D1Soqol	D2Soqol	D3Soqol	age	gender	ttype	prox_c~t	occl_adj	occl	pulp	acute_~o	chron_~o	AAE
BASEqol	1.0000													
D1Soqol	0.2177	1.0000												
D2Soqol	0.2007	0.7475*	1.0000											
D3Soqol	0.2059	0.6233*	0.8303*	1.0000										
age	0.2220*	-0.0781	-0.0707	-0.0102	1.0000									
gender	-0.0800	-0.1270	-0.0268	-0.0463	0.0466	1.0000								
ttype	-0.0661	0.0272	-0.0427	-0.0558	-0.1330	-0.2609*	1.0000							
prox_cont	-0.1311	0.1180	0.1837	0.0478	-0.2366*	0.0792	-0.0880	1.0000						
occl_adj	0.0678	0.1955	0.3061*	0.3132*	0.3258*	-0.0922	0.1710	-0.1621	1.0000					
occl	-0.0798	-0.0938	0.0938	0.0359	0.0290	0.0129	0.0317	0.2680*	0.1268	1.0000				
pulp	-0.0436	0.1667	0.0839	0.0775	0.0673	-0.1816	0.1137	-0.0261	0.3146*	0.0281	1.0000			
acute_perio	0.3997*	0.0855	0.0541	0.0689	-0.0086	-0.1022	-0.0440	-0.0856	0.0485	-0.0485	0.0178	1.0000		
chron_perio	0.0088	0.1863	0.2748*	0.2191	-0.0013	-0.0681	0.0301	-0.0049	0.4604*	-0.0274	0.5077*	0.1069	1.0000	
AAE	-0.1245	0.0694	-0.0511	-0.1234	-0.0817	0.0838	0.2179	-0.2740*	-0.0580	-0.4119*	-0.0072	-0.2916*	-0.0343	1.0000

/ BASEqol: /: The results revealed a modest yet statistically significant positive correlation between the impact on overall quality of life prior to treatment (/ BASEmax) and both the / age variable (0.22, P<0.05) and / acute_perio (0.4, P<0.05). For the remaining variables, the test indicated no statistically significant correlation with / BASEqol (P>0.05).

/ D1Soqol: The tests revealed no significant correlations between / D1Soqol and the predefined variables (P>0.05).

/ D2Soqol: A mild yet statistically significant positive correlation was identified between the impact on overall quality of life on the second day post-shaping treatment *(/ D2Soqol)* and factors such as occlusal adjustment (/ occl_adj) (correlation coefficient = 0.31, P<0.05) and the LEO parameter (/ chron_perio) (correlation coefficient = 0.28, P<0.05). For the remaining variables, there was no discernible correlation with / D2Soqol (P>0.05).

/ D3Soqol: A mild positive correlation was observed between the impact on overall quality of life on the third day post-shaping treatment (potentially a typo in the original text mentioning the second day) and occlusal adjustment (/ occl_adj) (correlation coefficient = 0.31, P<0.05). However, the other tested variables did not exhibit any significant correlation with / D3Soqol (P>0.05).

At this point, with the statistically significant outcomes from the Spearman test, we used ordered logistic regression to evaluate the potential influence of independent pre-operative clinical variables on the overall quality of life. This was assessed across multiple time points: prior to treatment, and on the first, second and third days post-treatment.

```
. ologit BASEqol i.age i.acute_perio, or

Iteration 0:   log likelihood =  -127.7935
Iteration 1:   log likelihood = -118.21141
Iteration 2:   log likelihood = -118.04443
Iteration 3:   log likelihood =  -118.0441
Iteration 4:   log likelihood =  -118.0441

Ordered logistic regression                         Number of obs =     80
                                                    LR chi2(4)    =  19.50
                                                    Prob > chi2   = 0.0006
Log likelihood = -118.0441                          Pseudo R2     = 0.0763
```

BASEqol	Odds ratio	Std. err.	z	P>|z|	[95% conf.	interval]
age						
4	2.039743	1.089408	1.33	0.182	.7160718	5.810243
5	4.524308	2.844265	2.40	0.016	1.319573	15.51212
6	2.249054	1.895621	0.96	0.336	.4310846	11.73376
1.acute_perio	5.760284	2.742334	3.68	0.000	2.265724	14.64471
/cut1	1.58113	.4902534			.6202508	2.542009
/cut2	1.645806	.4933625			.6788334	2.612779
/cut3	2.105001	.5151998			1.095228	3.114774
/cut4	2.719111	.5451223			1.650691	3.787531
/cut5	2.792009	.5489309			1.716125	3.867894
/cut6	3.752223	.619947			2.537149	4.967297
/cut7	4.040417	.6487515			2.768887	5.311946
/cut8	4.584974	.7112956			3.19086	5.979087
/cut9	5.539913	.896084			3.78362	7.296205

Note: Estimates are transformed only in the first equation to odds ratios.

Again, the results confirmed that this ordered regression model is more precise than without the predictors (Prob>chi2=0.00). Based on the ordered regression outcomes, the influence of the age and positive percussion on the level of impact on overall quality of life prior to treatment is statistically significant (p<0.05). For patients in the 5th age group (compared with those in the 3rd age group), exhibit a probability that is 4.52 times higher of reporting elevated pain levels, considering all consolidated pain scores. This observation holds true assuming other variables in the model remain constant.

Positive percussion increases the likelihood of the highest level of impact on the overall quality of life by a factor 5.76 when compared to all scores, assuming that all other variables within this model remain constant.

```
. ologit D2Soqol i.occl_adj i.chron_perio, or

Iteration 0:   log likelihood = -67.012034
Iteration 1:   log likelihood = -62.853519
Iteration 2:   log likelihood = -62.232133
Iteration 3:   log likelihood = -62.229562
Iteration 4:   log likelihood = -62.229562

Ordered logistic regression                             Number of obs =     80
                                                        LR chi2(3)    =   9.56
                                                        Prob > chi2   = 0.0227
Log likelihood = -62.229562                             Pseudo R2     = 0.0714

------------------------------------------------------------------------------
     D2Soqol | Odds ratio   Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
  1.occl_adj |    4.00635    3.23924     1.72   0.086      .821353    19.54195
             |
 chron_perio |
          1  |   3.119805    2.18395     1.63   0.104     .7911575    12.30246
          2  |   2.432749   1.819985     1.19   0.235     .5614327    10.54137
-------------+----------------------------------------------------------------
       /cut1 |   1.932167   .4360164                      1.077591    2.786744
       /cut2 |   2.581695   .4875266                       1.62616     3.53723
       /cut3 |   3.486878   .5958444                      2.319044    4.654711
       /cut4 |   3.739667   .6394307                      2.486405    4.992928
       /cut5 |   4.073493   .7078022                      2.686226     5.46076
------------------------------------------------------------------------------
Note: Estimates are transformed only in the first equation to odds ratios.
```

The results validate that this ordered regression model is sufficiently precise. (Prob>chi2=0.023). Based on the results of ordered regression, the influences of occlusal adjustment and LEO on the level of impact on overall quality of life on the second day following shaping treatment are not statistically significant (p>0.05).

```
. ologit D3Soqol i.occl_adj, or

Iteration 0:   log likelihood = -48.202919
Iteration 1:   log likelihood = -46.632006
Iteration 2:   log likelihood = -45.034896
Iteration 3:   log likelihood = -45.021333
Iteration 4:   log likelihood =  -45.02129
Iteration 5:   log likelihood =  -45.02129

Ordered logistic regression                             Number of obs =     80
                                                        LR chi2(1)    =   6.36
                                                        Prob > chi2   = 0.0117
Log likelihood = -45.02129                              Pseudo R2     = 0.0660
```

D3Soqol	Odds ratio	Std. err.	z	P>|z|	[95% conf.	interval]
1.occl_adj	7.687205	5.891714	2.66	0.008	1.711516	34.52676
/cut1	2.077051	.3748308			1.342396	2.811706
/cut2	2.922399	.4911557			1.959751	3.885046
/cut3	3.412104	.5856747			2.264203	4.560005
/cut4	4.935803	1.062281			2.85377	7.017836

Note: Estimates are transformed only in the first equation to odds ratios.

The findings further validate the precision of this ordered regression model, especially when considering the predictors used (Prob>chi2=0.01). Based on the analysis, the impact of the occlusal adjustment on the overall quality of life on the third day post-treatment is statistically significant (P=0.008) as it amplifies the effect by 6.11 times, assuming the other variables in the model remain constant.

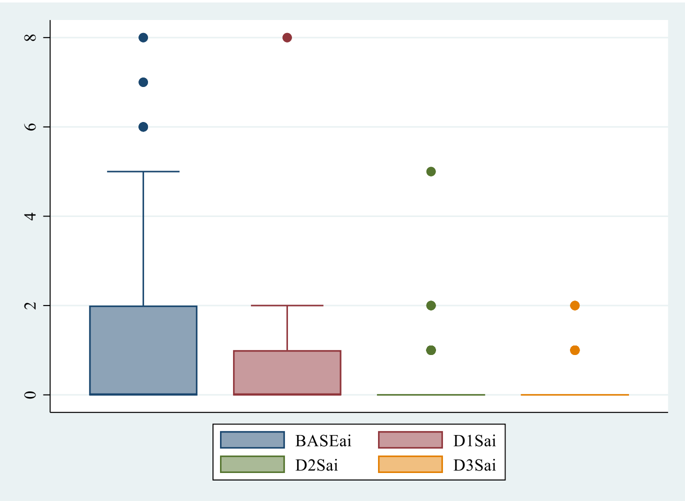
ANALGESIC INTAKE

The same analytical approach was used for variables related to the number of medications taken by patients at various stages of the treatment. Again, we used the Spearman correlation coefficient test to quantitatively evaluate the relationship between variables at distinct time points: the baseline before treatment (/ BASEai) and on the first, second, and third days following the shaping treatment (/ D1Sai, / D2Sai, / D3Sai).

```
. spearman BASEai D1Sai D2Sai D3Sai , star(.05)
(obs=80)

             |   BASEai    D1Sai    D2Sai    D3Sai
-------------+------------------------------------
      BASEai |   1.0000
       D1Sai |   0.2836*  1.0000
       D2Sai |   0.1853   0.6837*  1.0000
       D3Sai |   0.3316*  0.3733*  0.5084*  1.0000
```

Pic. 12 Analgesic intake before and after the shaping treatment



The result (Pic.12) reveals a low yet statistically significant positive correlation between analgesic intake on the first day after shaping treatment and before that (/ D1Sai vs. / BASEai, 0.28, $P<0.05$) and on the third day (0.33, $P<0.05$). The analgesic intake at the second and third days after shaping treatment (/ D2Sai, / D3Sai) vs. / D1Sai are moderately and low correlated, respectively (0.68; 0.37, P<0.05) Additionally, as well as the correlation between / D3Sai and / D2Sai exhibits a moderate and statistically significant correlation (0.51, P<0.05).

We also observed a consistent decline in analgesic intake (1.29; 0.44; 0.21; 0.12) following the shaping treatment. This decline is not statistically significant, as evidenced by the Friedman test (P=0.4):

```
. sum BASEai D1Sai D2Sai D3Sai

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
      BASEai |         80      1.2875    2.069634          0          8
       D1Sai |         80       .4375    1.065497          0          8
       D2Sai |         80       .2125    .6879386          0          5
       D3Sai |         80        .125    .4017367          0          2

. sum BASEqol D1Soqol D2Soqol D3Soqol

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
     BASEqol |         80      2.1375    2.717704          0          9
     D1Soqol |         80      1.1875    2.000593          0          8
     D2Soqol |         80       .5625    1.367283          0          6
     D3Soqol |         80       .3875    1.195919          0          6


. friedman BASEai D1Sai D2Sai D3Sai

Friedman =  80.3583
Kendall =    0.2543
P-value =    0.4363
```

At this point we used the Spearman correlation coefficient test to analyze the correlation between analgesic intake prior to treatment (/ BASEai), on the first, second, third day following the shaping treatment (/ D1Sai, / D2Sai, / D3Sai) as well as the clinical pre-operative variables:

. spearman BASEai D1Sai D2Sai D3Sai age gender ttype prox_cont occl_adj occl pulp acute_perio chron_perio AAE , star(.05)
(obs=80)

	BASEai	D1Sai	D2Sai	D3Sai	age	gender	ttype	prox_c~t	occl_adj	occl	pulp	acute_~o	chron_~o	AAE
BASEai	1.0000													
D1Sai	0.2836*	1.0000												
D2Sai	0.1853	0.6837*	1.0000											
D3Sai	0.3316*	0.3733*	0.5084*	1.0000										
age	0.2081	0.1407	-0.0791	0.0309	1.0000									
gender	0.0291	0.0669	0.0499	-0.0647	0.0466	1.0000								
ttype	-0.0500	-0.0297	-0.0766	0.1600	-0.1330	-0.2609*	1.0000							
prox_cont	-0.0874	-0.1776	0.0111	0.0122	-0.2366*	0.0792	-0.0880	1.0000						
occl_adj	0.0159	0.2656*	0.2221*	0.4084*	0.3258*	-0.0922	0.1710	-0.1621	1.0000					
occl	-0.0070	-0.0745	-0.0788	0.1186	0.0290	0.0129	0.0317	0.2680*	0.1268	1.0000				
pulp	-0.1942	0.0440	0.0286	-0.0335	0.0673	-0.1816	0.1137	-0.0261	0.3146*	0.0281	1.0000			
acute_perio	0.1827	0.0934	0.0507	0.0895	-0.0086	-0.1022	-0.0440	-0.0856	0.0485	-0.0485	0.0178	1.0000		
chron_perio	-0.1134	0.1050	0.0323	0.0634	-0.0013	-0.0681	0.0301	-0.0049	0.4604*	-0.0274	0.5077*	0.1069	1.0000	
AAE	0.0663	0.1370	0.1710	0.0355	-0.0817	0.0838	0.2179	-0.2740*	-0.0580	-0.4119*	-0.0072	-0.2916*	-0.0343	1.0000

.

/ BASEai: The results did not reveal any statistically significant correlation between analgesic intake prior to the treatment (/ BASEai) and any other variable.

/ D1Sai: The results revealed little if any (linear) statistically significant positive correlation magnitude between analgesic intake on the first day after shaping treatment (/ D1Sai) and occlusal adjustment (/ occl_adj) (0.27, $P<0.05$). No significant correlation was observed between / D1Sai ($P>0.05$) and the other variables tested.

/ D2Sai: On the second day following the shaping treatment, little if any statistically significant positive correlation was observed between the analgesic intake and occlusal adjustment (/ occl_adj) with a correlation coefficient of 0.22 ($P<0.05$). For other variables, no significant correlation with / D2Sai was detected ($P>0.05$).

/ D3Sai: The results revealed a low but statistically significant positive correlation magnitude between analgesic intake on the third day following the shaping treatment (/ D3Sai) and occlusal adjustment (/ occl_adj) (0.41, $P<0.05$). For other variables, no statistically significant correlation was found. / D3Sai ($P>0.05$).

At this point, with the statistically significant correlated results from the Spearman test, we used ordered logistic regression to assess the influence of independent pre-operative clinical variables on analgesic intake across various time intervals (prior to treatment, on the first, second and third day):

```
. ologit D1Sai i.occl_adj, or

Iteration 0:   log likelihood = -63.021709
Iteration 1:   log likelihood =   -60.6687
Iteration 2:   log likelihood = -60.382029
Iteration 3:   log likelihood = -60.381701
Iteration 4:   log likelihood = -60.381701

Ordered logistic regression                         Number of obs =     80
                                                    LR chi2(1)    =   5.28
                                                    Prob > chi2   = 0.0216
Log likelihood = -60.381701                         Pseudo R2     = 0.0419

------------------------------------------------------------------------------
       D1Sai | Odds ratio   Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
  1.occl_adj |   5.336866   3.795209     2.35   0.019     1.324253    21.50809
-------------+----------------------------------------------------------------
       /cut1 |   1.248044   .2831843                       .693013    1.803075
       /cut2 |   2.480454   .4106259                      1.675642    3.285266
       /cut3 |   4.733519   1.032368                      2.710114    6.756923
------------------------------------------------------------------------------
Note: Estimates are transformed only in the first equation to odds ratios.
```

The results once again affirmed the precision of this ordered regression model, attributed to the chosen predictors (Prob>chi2=0.02). Based on the findings from the ordered regression, there is a significant influence of occlusal adjustment on the quantity of analgesics taken on the first day post-shaping treatment (P=0.019). Specifically, the presence of occlusal adjustment amplifies the likelihood of increased analgesic intake by 5.34 times, assuming other variables in this model remain constant.

```
. ologit D2Sai i.occl_adj, or

Iteration 0:   log likelihood = -40.386955
Iteration 1:   log likelihood = -39.277215
Iteration 2:   log likelihood = -38.695094
Iteration 3:   log likelihood = -38.693079
Iteration 4:   log likelihood = -38.693079

Ordered logistic regression                         Number of obs =     80
                                                    LR chi2(1)    =   3.39
                                                    Prob > chi2   = 0.0657
Log likelihood = -38.693079                         Pseudo R2     = 0.0419
```

D2Sai	Odds ratio	Std. err.	z	P>|z|	[95% conf. interval]	
1.occl_adj	4.92471	3.99446	1.97	0.049	1.004538	24.14321
/cut1	2.081278	.3748225			1.34664	2.815917
/cut2	3.538303	.6307004			2.302153	4.774453
/cut3	4.704089	1.039306			2.667086	6.741092

Note: Estimates are transformed only in the first equation to odds ratios.

Similarly, on the second day following shaping treatment, the ordered regression results indicated a notable influence of occlusal adjustment on the amount of analgesics consumed. Occlusal adjustment enhances the likelihood of increased analgesic intake by 4.92 times, assuming all other variables in this model remain constant (P=0.049).

```
. ologit D3Sai i.occl_adj, or

Iteration 0:   log likelihood = -30.505319
Iteration 1:   log likelihood = -26.440965
Iteration 2:   log likelihood = -26.123185
Iteration 3:   log likelihood = -26.122736
Iteration 4:   log likelihood = -26.122736

Ordered logistic regression                         Number of obs =     80
                                                    LR chi2(1)    =   8.77
                                                    Prob > chi2   = 0.0031
Log likelihood = -26.122736                         Pseudo R2     = 0.1437
```

D3Sai	Odds ratio	Std. err.	z	P>|z|	[95% conf. interval]	
1.occl_adj	12.8712	10.71011	3.07	0.002	2.519622	65.75108
/cut1	2.815549	.5146735			1.806808	3.824291
/cut2	4.459969	.8427921			2.808127	6.111811

Note: Estimates are transformed only in the first equation to odds ratios.

This ordered regression model is also sufficiently precise due to the predictors used. (Prob>chi2=0.0031). Based on the ordered regression results, the influence of occlusal adjustment on the level of analgesic intake on the third day following shaping treatment is significant (P=0.002) and increases it by 12.87 times, assuming all other variables in this model remain constant.

III. ASSESSMENT OF THE CORRELATION POSSIBILITY OF THE PRE-OPERATIVE VARIABLES AND PAIN LEVELS AFTER SHAPING AND FILLING INTERVENTION (MAX, QOL, AI)

The comparison of maximal pain levels after shaping and filling interventions at the first, second, third days showed that:

```
. ttest D1Smax = D1Fmax

Paired t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
  D1Smax |      80         3.4     .306367     2.74023    2.790192    4.009808
  D1Fmax |      80       1.475     .195661    1.750045    1.085547    1.864453
---------+--------------------------------------------------------------------
    diff |      80       1.925    .2861657    2.559544    1.355401    2.494599
------------------------------------------------------------------------------
     mean(diff) = mean(D1Smax - D1Fmax)                            t =   6.7269
 H0: mean(diff) = 0                               Degrees of freedom =       79

 Ha: mean(diff) < 0           Ha: mean(diff) != 0           Ha: mean(diff) > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

```
. ttest D2Smax = D2Fmax

Paired t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
  D2Smax |      80         1.7    .2803705     2.50771    1.141937    2.258063
  D2Fmax |      80          .6    .1606947    1.437297    .2801452    .9198548
---------+--------------------------------------------------------------------
    diff |      80         1.1    .2827308    2.528821    .5372384    1.662762
------------------------------------------------------------------------------
     mean(diff) = mean(D2Smax - D2Fmax)                           t =   3.8906
 H0: mean(diff) = 0                              Degrees of freedom =       79

 Ha: mean(diff) < 0           Ha: mean(diff) != 0           Ha: mean(diff) > 0
 Pr(T < t) = 0.9999         Pr(|T| > |t|) = 0.0002          Pr(T > t) = 0.0001


. ttest D3Smax = D3Fmax

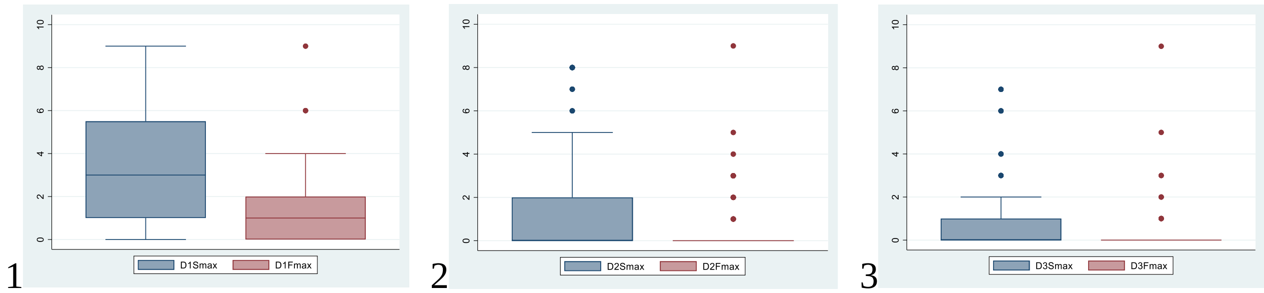
Paired t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
  D3Smax |      80       .9625    .2115672    1.892315     .541386    1.383614
  D3Fmax |      80       .3625    .1414703    1.265349    .0809104    .6440896
---------+--------------------------------------------------------------------
    diff |      80          .6    .2131737    1.906684    .1756883    1.024312
------------------------------------------------------------------------------
     mean(diff) = mean(D3Smax - D3Fmax)                           t =   2.8146
 H0: mean(diff) = 0                              Degrees of freedom =       79

 Ha: mean(diff) < 0           Ha: mean(diff) != 0           Ha: mean(diff) > 0
 Pr(T < t) = 0.9969         Pr(|T| > |t|) = 0.0062          Pr(T > t) = 0.0031
```

- on the first day the level of maximal pain after shaping (/ D1Smax mean= 3.4) was higher than after the filling (/ D1Fmax mean= 1.475) with significant differences between these variables (P< 0.001);
- on the second day the level of maximal pain after shaping (/ D2Smax mean=1.7) was also higher than after the filling (/ D2Fmax mean= 0.6) with significant differences between these variables (P< 0.001);
- on the third day the level of maximal pain after shaping (/ D3Smax mean=0.96) was also higher than after the filling (/ D3Fmax mean=0.36) with significant differences between these variables (P=0.02).

Thus, the results of the analysis indicate that the shaping intervention caused a higher level of pain compared to the filling intervention during all three days after on. This may indicate that the first step of the treatment is more intense and may result in higher patient's postoperative pain.

Pic.13 Maximal pain levels after shaping and filling treatment on the first (D1Smax, D1Fmax), second (D2Smax, D2Fmax) and third day (D3Smax, D3Fmax)



From these box-plots (Pic.13) we see a decrease in level of pain on the first, second and third day following shaping and filling treatment and observe that filling treatment causes less pain when compared with shaping.

Before going into the details of post-filling pain we compiled a summary table presenting the average values for maximal pain, the impact on the overall quality of life, and analgesic intake across the first, second, and third days post-filling treatment, segmented by obturation groups (Tab.3).

Tab. 3 Summary of the average maximal pain (MAX), the impact on the overall quality of life (QOL), and the analgesic intake (AI) after the filling treatment (F) over the first three days, categorized by obturation groups (/obtur).

		Day 1			Day 2			Day 3		
F	/ obtur	Mean	SD	p-value	Mean	Sd	p-value	Mean	Sd	p-value
Max	1	0,4	0,681	0,00203	0,3	0,923	0,000347	0	0	-
	2	1,05	1,47	0,0174	0,15	0,489	0,00000053	0	0	-
	3	2,6	2,16	0,609	1,6	2,28	0,0051	1,35	2,28	-
	4	1,85	1,6	0,343	0,35	0,933	0,00000584	0,1	0,308	-
		Day 1			Day 2			Day 3		
Qol	1	0,2	0,616	0,000347	0,2	0,616	-	0	0	-
	2	0,05	0,224	0,000057	0	0	-	0	0	-
	3	0,95	2,26	0,000000431	0,85	2,11	-	0,7	1,95	-
	4	0,05	0,224	0,000057	0	0	-	0	0	-
		Day 1			Day 2			Day 3		
AI	1	0	0	-	0	0	-	0	0	-
	2	0,2	0,523	-	0	0	-	0	0	-
	3	0,35	0,587	-	0,15	0,489	-	0,2	0,523	-
	4	0,1	0,308	-	0	0	-	0	0	-

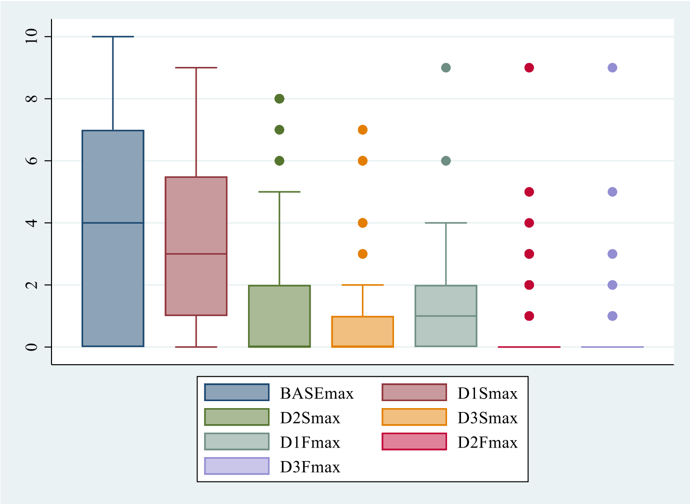
MAXIMAL PAIN

Although we deliberately incorporated a one-week break following shaping treatment to exclude the potential influence of postoperative pain from the shaping phase on pain experienced after the filling stage, we decided to apply the Spearman correlation coefficient test again – a quantitative evaluation of the relationship between variables concerning the maximal pain levels at various intervals: the first, second, and third days post-filling treatment (denoted as / D1Fmax, / D2Fmax, / D3Fmax):

```
. spearman BASEmax D1Smax D2Smax D3Smax D1Fmax D2Fmax D3Fmax , star(.05)
(obs=80)

             |  BASEmax   D1Smax   D2Smax   D3Smax   D1Fmax   D2Fmax   D3Fmax
-------------+---------------------------------------------------------------
     BASEmax |   1.0000
      D1Smax |   0.4098*  1.0000
      D2Smax |   0.2047   0.7574*  1.0000
      D3Smax |   0.1327   0.5905*  0.8215*  1.0000
      D1Fmax |   0.0941   0.5116*  0.4608*  0.3366*  1.0000
      D2Fmax |  -0.0337   0.1867   0.3345*  0.4481*  0.5271*  1.0000
      D3Fmax |  -0.0093   0.2296*  0.3801*  0.4631*  0.4619*  0.7778*  1.0000
```

Pic. 14 Maximal pain prior to and following shaping and filling treatment



The results (Pic.14) revealed a statistically significant moderate positive correlation (0.5271, P<0.05) between the pain level on the first and second days following filling treatment (/ D1Fmax and / D2Fmax), also on the first and third day following filling (0.4619, P<0.05, / D1Fmax and D3Fmax. Additionally, the correlation between the pain experienced on the third day with that on the second day (/ D2Fmax and / D3Fmax) was notably strong and statistically significant, with a value of 0.78 (P<0.05).

Taking into the account the potential for correlated pain levels following the shaping and filling procedures, we observed a statistically significant positive correlation, as outlined in Table 4:

Tab. 4 Correlation of the pain levels following shaping and filling interventions.

/ D1Fmax and	/ D1Smax	0.5116, P<0.05	moderate
	/ D2Smax	0.4608, P<0.05	moderate
	/ D3Smax	0.3366, P<0.05	moderate

/ D2Fmax and	/ D1Smax	-	-
	/ D2Smax	0.3345, P<0.05	moderate
	/ D3Smax	0.4481, P<0.05	moderate
/ D3Fmax and	/ D1Smax	0.2296, P<0.05	weak
	/ D2Smax	0.3801, P<0.05	moderate
	/ D3Smax	0.4631, P<0.05	moderate

We observed no correlation between pain levels before the treatment and those after the filling procedure.

Additionally, we noted a consistent decline in the maximal pain level (3.9375; 1.475; 0.6; 0.3625) following the filling treatment. However, this decrease was not statistically significant as confirmed by the Friedman test (P=0.0991):

```
. sum BASEmax D1Fmax D2Fmax D3Fmax

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
     BASEmax |         80      3.9375    3.380299          0         10
      D1Fmax |         80       1.475    1.750045          0          9
      D2Fmax |         80          .6    1.437297          0          9
      D3Fmax |         80       .3625    1.265349          0          9

. friedman BASEmax D1Fmax D2Fmax D3Fmax

Friedman =  95.5468
Kendall =    0.3024
P-value =    0.0991
```

At this point we employed the Spearman correlation coefficient test to analyze the correlation between the maximal pain level following filling treatment (/ D1Fmax, / D2Fmax, / D3Fmax) and the clinical pre-operative variables:

```
. spearman D1Fmax D2Fmax D3Fmax age gender ttype prox_cont occl_adj occl pulp acute_perio chron_perio AAE , star(.05)
(obs=80)
```

	D1Fmax	D2Fmax	D3Fmax	age	gender	ttype	prox_c~t	occl_adj	occl	pulp	acute_~o	chron_~o	AAE
D1Fmax	1.0000												
D2Fmax	0.5271*	1.0000											
D3Fmax	0.4619*	0.7778*	1.0000										
age	-0.2664*	-0.2014	-0.1244	1.0000									
gender	-0.0737	-0.0371	-0.1615	0.0466	1.0000								
ttype	0.0072	0.0370	-0.0823	-0.1330	-0.2609*	1.0000							
prox_cont	0.0466	0.0726	0.0060	-0.2366*	0.0792	-0.0880	1.0000						
occl_adj	-0.0483	0.0692	0.0859	0.3258*	-0.0922	0.1710	-0.1621	1.0000					
occl	-0.0608	0.0762	0.0129	0.0290	0.0129	0.0317	0.2680*	0.1268	1.0000				
pulp	0.0957	-0.0256	0.0994	0.0673	-0.1816	0.1137	-0.0261	0.3146*	0.0281	1.0000			
acute_perio	-0.0136	0.1719	0.0507	-0.0086	-0.1022	-0.0440	-0.0856	0.0485	-0.0485	0.0178	1.0000		
chron_perio	0.2721*	0.1211	0.1112	-0.0013	-0.0681	0.0301	-0.0049	0.4604*	-0.0274	0.5077*	0.1069	1.0000	
AAE	0.1428	0.0274	-0.0631	-0.0817	0.0838	0.2179	-0.2740*	-0.0580	-0.4119*	-0.0072	-0.2916*	-0.0343	1.0000

/ D1Fmax: We found a weak yet statistically significant positive correlation between the maximal pain experienced on the first day post-filling treatment and the variables: age (-0.2664, $P<0.05$) and the LEO parameter (/ chron_perio) (0.27, $P<0.05$). No significant correlations were observed between / D1Fmax and the remaining variables ($P>0.05$).

Both / D2Fmax and / D3Fmax demonstrated no statistically significant correlations with any of the examined variables ($P>0.05$).

At this point, with the statistically significant correlations through the Spearman test, we employed ordered logistic regression to evaluate the impact of age and the LEO parameter (/ chron_perio) on the pain level experienced on the first day post-filling treatment (/ D1Fmax):

```
. ologit D1Fmax i.age i.chron_perio, or

Iteration 0:   log likelihood = -126.50109
Iteration 1:   log likelihood = -115.69188
Iteration 2:   log likelihood =  -115.4656
Iteration 3:   log likelihood = -115.46499
Iteration 4:   log likelihood = -115.46499

Ordered logistic regression                             Number of obs =     80
                                                        LR chi2(5)    =  22.07
                                                        Prob > chi2   = 0.0005
Log likelihood = -115.46499                             Pseudo R2     = 0.0872

------------------------------------------------------------------------------
      D1Fmax | Odds ratio   Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         age |
           4 |   .3509754   .1831124    -2.01   0.045     .1262363    .9758187
           5 |   .4118801    .252572    -1.45   0.148     .1238224    1.370069
           6 |   .0324266   .0388133    -2.86   0.004     .0031049     .338653
             |
 chron_perio |
           1 |   7.826434   4.786236     3.36   0.001     2.360553    25.94861
           2 |   2.792543   1.550911     1.85   0.064     .9402927    8.293479
-------------+----------------------------------------------------------------
       /cut1 |  -.5692986   .3864716                     -1.326769    .1881719
       /cut2 |   .3046851   .3816734                      -.443381    1.052751
       /cut3 |   1.298886   .4229543                      .4699112    2.127862
       /cut4 |    2.19588    .487318                      1.240754    3.151006
       /cut5 |   3.568349   .6900252                      2.215924    4.920773
       /cut6 |   4.731739   1.071217                      2.632191    6.831286
------------------------------------------------------------------------------
Note: Estimates are transformed only in the first equation to odds ratios.
```

As indicated by the results, this ordered regression model demonstrates enhanced precision when incorporating the predictors (Prob>chi2=0.0005). Based on the outcomes of the ordered regression, both age and the LEO parameter (/ chron_perio) significantly influence the maximal pain level experienced on the first day post-filling treatment (P<0.05).

A LEO measurement of less than 2 mm (in comparison to patients without LEO) increases the likelihood of experiencing the most severe pain level, when compared to all combined pain scores, by a factor of 7.826 (P=0.001), assuming other variables in the model remain constant.

For patients in the 4th age group, aged 40-49 years (compared to those in the 3rd age group, 30-39 years), the likelihood of experiencing a more intense pain level, in relation to all combined pain scores, increases by a factor of 0.351 (P=0.045), assuming other variables in the model are constant. For those in the 6th age group, aged 60-69 years (relative to those in the 3rd age group, 30-39 years), the likelihood of a heightened pain level, in comparison to all combined pain scores, increases by a factor of 0.324 (P=0.04), assuming all other variables in the model are constant.

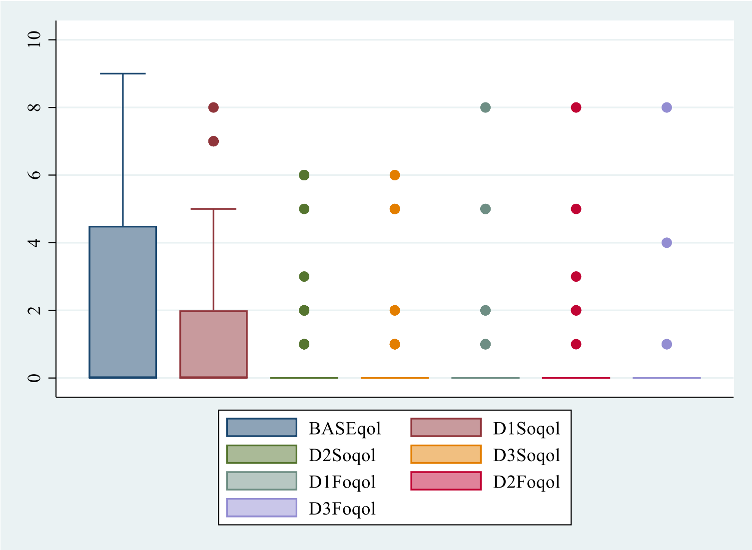
IMPACT ON OVERALL QUALITY OF LIFE

Although we deliberately incorporated a one-week break following shaping treatment to exclude the potential influence of postoperative pain from the shaping phase on pain experienced after the filling stage, we decided to employ the Spearman correlation coefficient test again – a quantitative evaluation of the statistical relationship between variables or events – to examine the impact on the overall quality of life at various intervals: on the first, second, and third days following the filling treatment (denoted as / D1Foqol, / D2Foqol, / D3Foqol):

```
. spearman BASEqol D1Soqol D2Soqol D3Soqol D1Foqol D2Foqol D3Foqol , star(.05)
(obs=80)
```

	BASEqol	D1Soqol	D2Soqol	D3Soqol	D1Foqol	D2Foqol	D3Foqol
BASEqol	1.0000						
D1Soqol	0.2177	1.0000					
D2Soqol	0.2007	0.7475*	1.0000				
D3Soqol	0.2059	0.6233*	0.8303*	1.0000			
D1Foqol	0.1181	0.1956	0.2530*	0.2612*	1.0000		
D2Foqol	0.1423	0.1237	0.3295*	0.3268*	0.8736*	1.0000	
D3Foqol	0.2122	0.3018*	0.4506*	0.5722*	0.5371*	0.6176*	1.0000

Pic. 15 Impact on the quality of life prior to and following shaping and filling treatment.



The results (Pic.15) revealed a strong positive correlation (0.8736, P<0.05) between the impact on overall quality of life on the first and second days post-filling treatment (/ D1Foqol and / D2Foqol). Additionally, a moderate positive correlation was observed both between the first and third days post-filling (0.5371, P<0.05, between / D1Foqol and D3Foqol) and between the second and third days (/ D2Foqol and / D3Foqol), with the latter indicating a significant, moderate, correlation coefficient of 0.6176 (P<0.05).

Taking into account the potential correlation between the impact on overall quality of life post-shaping and post-filling procedures, we observed a statistically significant positive correlation (Tab.5):

Tab. 5 Correlation of the impact on overall quality of life following shaping and filling interventions.

/ D1Foqol and	/ D1soqol	-	-
	/ D2Soqol	0.2530, P<0.05	weak
	/ D3Soqol	0.2612, P<0.05	weak
/ D2Foqol and	/ D1Soqol	-	-
	/ D2Soqol	0.3295, P<0.05	moderate
	/ D3Soqol	0.3268, P<0.05	moderate
/ D3Foqol and	/ D1Soqol	0.3018, P<0.05	moderate
	/ D2Soqol	0.4506, P<0.05	moderate
	/ D3Soqol	0.5722, P<0.05	moderate

We observed no correlation of the impact on overall quality of life before the treatment and after filling intervention.

We also noted a consistant decrease of the impact on overall quality of life (3.9375; 1.475; 0.6; 0.3625) following the filling treatmen. However, this decrease is not statistically significant, as confirmed by the Friedman test (P=0.0991):

```
. sum BASEmax D1Fmax D2Fmax D3Fmax

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
     BASEmax |         80      3.9375    3.380299          0         10
      D1Fmax |         80       1.475    1.750045          0          9
      D2Fmax |         80          .6    1.437297          0          9
      D3Fmax |         80       .3625    1.265349          0          9

. friedman BASEmax D1Fmax D2Fmax D3Fmax

Friedman =  95.5468
Kendall =    0.3024
P-value =    0.0991
```

At this point we employed the Spearman correlation coefficient test to analyze the correlation between the impact on overall quality of life following filling treatment (/ D1Foqol, / D2Foqol, / D3Foqol) and the clinical pre-operative variables:

```
. spearman D1Foqol D2Foqol D3Foqol age gender ttype prox_cont occl_adj occl pulp acute_perio chron_perio AAE , star(.05)
(obs=80)
```

	D1Foqol	D2Foqol	D3Foqol	age	gender	ttype	prox_c~t	occl_adj	occl	pulp	acute_~o	chron_~o	AAE
D1Foqol	1.0000												
D2Foqol	0.8736*	1.0000											
D3Foqol	0.5371*	0.6176*	1.0000										
age	-0.0921	-0.0071	0.0361	1.0000									
gender	0.1022	0.1070	0.0115	0.0466	1.0000								
ttype	0.1599	0.1367	-0.0331	-0.1330	-0.2609*	1.0000							
prox_cont	0.0771	0.0683	0.0576	-0.2366*	0.0792	-0.0880	1.0000						
occl_adj	0.0197	0.0506	0.0953	0.3258*	-0.0922	0.1710	-0.1621	1.0000					
occl	-0.1481	-0.0581	-0.1066	0.0290	0.0129	0.0317	0.2680*	0.1268	1.0000				
pulp	0.0835	-0.0009	0.0582	0.0673	-0.1816	0.1137	-0.0261	0.3146*	0.0281	1.0000			
acute_perio	0.1758	0.1933	0.1190	-0.0086	-0.1022	-0.0440	-0.0856	0.0485	-0.0485	0.0178	1.0000		
chron_perio	0.0584	0.0326	-0.0017	-0.0013	-0.0681	0.0301	-0.0049	0.4604*	-0.0274	0.5077*	0.1069	1.0000	
AAE	0.0736	0.0492	-0.1126	-0.0817	0.0838	0.2179	-0.2740*	-0.0580	-0.4119*	-0.0072	-0.2916*	-0.0343	1.0000

The test showed no statistically significant correlation magnitude within the variables / D1Foqol, / D2Foqol, / D3Foqol (P>0.05).

At this point, we shifted our focus to the analysis of variables associated with analgesic intake following filling treatment.

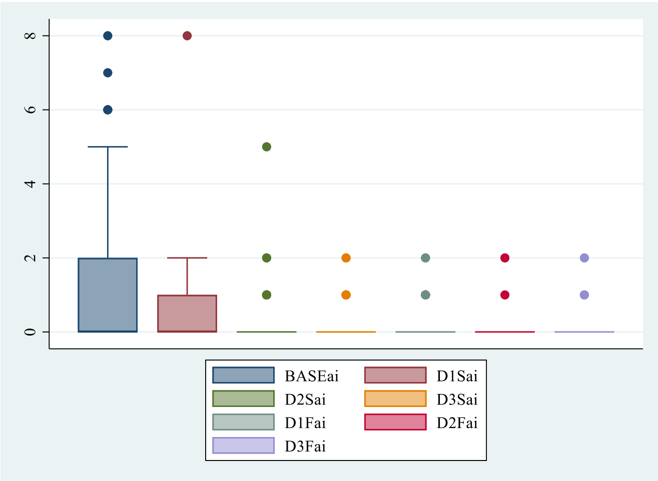
ANALGESIC INTAKE

Although we deliberately incorporated a one-week break following shaping treatment to exclude the potential influence of postoperative pain from the shaping phase on pain experienced after the filling stage, we decided to employ the Spearman correlation coefficient test once again – a quantitative evaluation of the statistical relationship between variables or events – to examine the impact of analgesic intake at different time intervals: on the first, second and third days after filling treatment (/ D1Fai, / D2Fai, / D3Fai):

```
. spearman BASEai D1Sai D2Sai D3Sai D1Fai D2Fai D3Fai , star(.05)
(obs=80)

             |   BASEai    D1Sai    D2Sai    D3Sai    D1Fai    D2Fai    D3Fai
-------------+---------------------------------------------------------------
      BASEai |   1.0000
       D1Sai |   0.2836*  1.0000
       D2Sai |   0.1853   0.6837*  1.0000
       D3Sai |   0.3316*  0.3733*  0.5084*  1.0000
       D1Fai |   0.1338   0.3375*  0.2748*  0.1085   1.0000
       D2Fai |   0.0523   0.1099   0.1853   0.2297*  0.4211*  1.0000
       D3Fai |   0.0833   0.0515   0.1261   0.1668   0.3224*  0.8165*  1.0000
```

Pic. 16 Analgesic intake prior to and following shaping and filling treatment



The results (Pic.16) revealed a statistically significant moderate positive correlation (0.4211, P<0.05) between analgesic intake on the first and second days following filling treatment (/ D1Fai and / D2Fai), also on the first and third day after filling (0.3224, P<0.05, / D1Fai and D3Fai). A strong correlation was noted between the third and second days (/ D2Fai and / D3Fai) with a magnitude of 0.8165 (P<0.05).

We observed no correlation between analgesic intake prior to the treatment and post-shaping and filling interventions.

Additionally, we noted a consistent decline in analgesic intake following the filling treatment, with values of 1.2875, 0.1625, 0.0375, and 0.5 sequentially. This reduction was confirmed to be statistically significant as indicated by the Friedman test (P=0.00):

```
. sum BASEai D1Sai D2Sai D3Sai D1Fai D2Fai D3Fai
```

Variable	Obs	Mean	Std. dev.	Min	Max
BASEai	80	1.2875	2.069634	0	8
D1Sai	80	.4375	1.065497	0	8
D2Sai	80	.2125	.6879386	0	5
D3Sai	80	.125	.4017367	0	2
D1Fai	80	.1625	.4341076	0	2
D2Fai	80	.0375	.248731	0	2
D3Fai	80	.05	.270957	0	2

```
. friedman BASEmax D1Smax D2Smax D3Smax D1Fmax D2Fmax D3Fmax

Friedman = 190.5298
Kendall =    0.3445
P-value =    0.0000
```

At this point we employed the Spearman correlation coefficient test to analyze the correlation between analgesic intake following filling treatment (/ D1Fai, / D2Fai, / D3Fai) and the clinical pre-operative variables:

```
. spearman D1Fai D2Fai D3Fai age gender ttype prox_cont occl_adj occl pulp acute_perio chron_perio AAE , star(.05)
(obs=80)
```

	D1Fai	D2Fai	D3Fai	age	gender	ttype	prox_c~t	occl_adj	occl	pulp	acute_~o	chron_~o	AAE
D1Fai	1.0000												
D2Fai	0.4211*	1.0000											
D3Fai	0.3224*	0.8165*	1.0000										
age	0.0494	0.0404	0.1437	1.0000									
gender	0.1363	-0.1485	-0.1831	0.0466	1.0000								
ttype	-0.1834	0.0769	0.0948	-0.1330	-0.2609*	1.0000							
prox_cont	0.0615	0.1775	0.1045	-0.2366*	0.0792	-0.0880	1.0000						
occl_adj	-0.0301	-0.0570	0.1353	0.3258*	-0.0922	0.1710	-0.1621	1.0000					
occl	-0.1133	-0.1995	-0.1431	0.0290	0.0129	0.0317	0.2680*	0.1268	1.0000				
pulp	0.0125	0.0414	0.1041	0.0673	-0.1816	0.1137	-0.0261	0.3146*	0.0281	1.0000			
acute_perio	0.1967	0.0060	0.0724	-0.0086	-0.1022	-0.0440	-0.0856	0.0485	-0.0485	0.0178	1.0000		
chron_perio	0.1334	-0.0004	0.0500	-0.0013	-0.0681	0.0301	-0.0049	0.4604*	-0.0274	0.5077*	0.1069	1.0000	
AAE	-0.0262	-0.1424	-0.1756	-0.0817	0.0838	0.2179	-0.2740*	-0.0580	-0.4119*	-0.0072	-0.2916*	-0.0343	1.0000

The results revealed no statistically significant correlation among any of the variables related to analgesic intake (P>0.05).

IV. ASSESSMENT OF THE INFLUENCE OF THE OBTURATION GROUP ON POST-OPERATIVE PAIN LEVELS (MAX, QOL, AI) AND ASSESSMENT OF THE DETAILED PAIN VARIABLES FOLLOWING FILLING INTERVENTION

MAXIMAL PAIN

Based on the data presented and the accompanying graphs (Pic.17) detailing the levels of maximal pain post-filling treatment across each obturation group (on the first, second, and third days), we can draw the following conclusions:

```
. sum D1Fmax D2Fmax D3Fmax if obtur ==1

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
      D1Fmax |         20          .4     .680557          0          2
      D2Fmax |         20          .3    .9233805          0          3
      D3Fmax |         20           0           0          0          0

. sum D1Fmax D2Fmax D3Fmax if obtur ==2

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
      D1Fmax |         20        1.05    1.468081          0          6
      D2Fmax |         20         .15    .4893605          0          2
      D3Fmax |         20           0           0          0          0

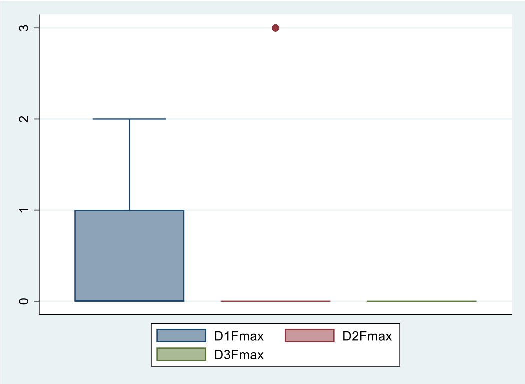
. sum D1Fmax D2Fmax D3Fmax if obtur ==3

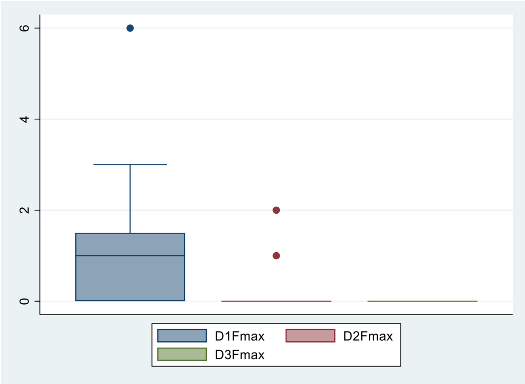
    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
      D1Fmax |         20         2.6    2.161871          0          9
      D2Fmax |         20         1.6    2.280351          0          9
      D3Fmax |         20        1.35    2.277464          0          9

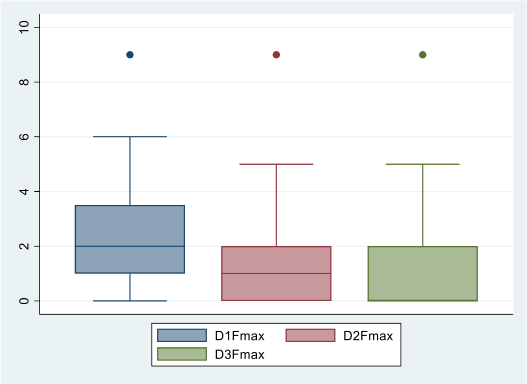
. sum D1Fmax D2Fmax D3Fmax if obtur ==4

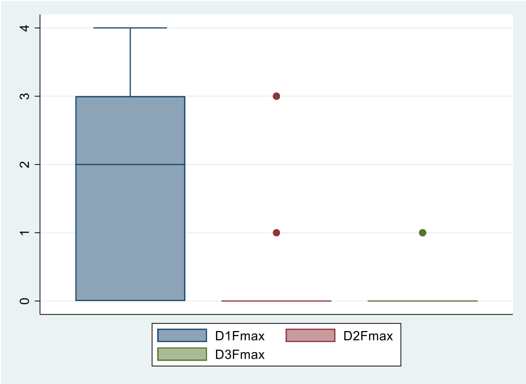
    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
      D1Fmax |         20        1.85    1.598519          0          4
      D2Fmax |         20         .35     .933302          0          3
      D3Fmax |         20          .1    .3077935          0          1
```

Fig. 17 Maximal pain levels following filling treatment on the first, second and third day (D1Fmax, D2Fmax, D3Fmax) of each obturation group (1,2,3,4)

1 

2 

3 

4 

-on the first day after the filling stage of treatment, obturation group 4 (AH_w) has the highest mean of maximal pain level (1.85), while obturation group 1 (BC_c) has the lowest mean of maximal pain level (0.4);

-on the second day after the filling stage of treatment, obturation group 3 (AH_c) demonstrated the highest level of mean of maxinal pain (1.6). Obturation group 2 (BC_w) demonstrated the lowest mean (0.15). This group also had the strongest reduction when compared with the first day (7 times);

-on the third day after the filling stage of treatment, obturation group 3 (AH_c) still had the highest mean of maximal pain (1.35). Groups BC_c and BC_w had no pain, while obturation group AH_w had a low mean of maximal pain (0.1).

Overall, obturation groups 1 and 2 (BC_c, BC_w) had a lower mean level of pain at all stages of treatment and on each day compared to other obturation groups. This may suggest that bioceramic sealer use can be beneficial. Obturation groups 3 and 4 (AH_c, AH_w) had the highest mean level of pain at all stages of treatment and on each day. This may suggest that these groups experienced more intense pain.

The Tukey test was used to evaluate the differences between the obturation groups:

```
. pwmean D1Fmax, over(obtur) mcompare(tukey) effects
```

Pairwise comparisons of means with equal variances

Over: obtur

	Number of comparisons
obtur	6

D1Fmax	Contrast	Std. err.	Tukey t	Tukey P>|t|	Tukey [95% conf.	interval]
obtur						
2 vs 1	.65	.4961695	1.31	0.559	-.6533365	1.953337
3 vs 1	2.2	.4961695	4.43	0.000	.8966635	3.503337
4 vs 1	1.45	.4961695	2.92	0.023	.1466635	2.753337
3 vs 2	1.55	.4961695	3.12	0.013	.2466635	2.853337
4 vs 2	.8	.4961695	1.61	0.378	-.5033365	2.103337
4 vs 3	-.75	.4961695	-1.51	0.436	-2.053337	.5533365

```
. pwmean D2Fmax, over(obtur) mcompare(tukey) effects
```

Pairwise comparisons of means with equal variances

Over: obtur

	Number of comparisons
obtur	6

D2Fmax	Contrast	Std. err.	Tukey t	Tukey P>|t|	Tukey [95% conf.	interval]
obtur						
2 vs 1	-.15	.4231772	-0.35	0.985	-1.2616	.9616005
3 vs 1	1.3	.4231772	3.07	0.015	.1883995	2.4116
4 vs 1	.05	.4231772	0.12	0.999	-1.0616	1.1616
3 vs 2	1.45	.4231772	3.43	0.005	.3383995	2.5616
4 vs 2	.2	.4231772	0.47	0.965	-.9116005	1.3116
4 vs 3	-1.25	.4231772	-2.95	0.021	-2.3616	-.1383995

```
. pwmean D3Fmax, over(obtur) mcompare(tukey) effects
```

Pairwise comparisons of means with equal variances

Over: obtur

	Number of comparisons
obtur	6

D3Fmax	Contrast	Std. err.	Tukey t	Tukey P>|t|	Tukey [95% conf.	interval]
obtur						
2 vs 1	6.45e-16	.3633724	0.00	1.000	-.9545053	.9545053
3 vs 1	1.35	.3633724	3.72	0.002	.3954947	2.304505
4 vs 1	.1	.3633724	0.28	0.993	-.8545053	1.054505
3 vs 2	1.35	.3633724	3.72	0.002	.3954947	2.304505
4 vs 2	.1	.3633724	0.28	0.993	-.8545053	1.054505
4 vs 3	-1.25	.3633724	-3.44	0.005	-2.204505	-.2954947

This test revealed statistically significant differences in maximal pain among the obturation groups. These variations underscore the influence of the obturation technique on the postoperative pain level:

Day after filling treatment	Obturation groups	P
/ D1Fmax	3-1	0.00
	4-1	0.023
	3-2	0.013
/ D2Fmax	3-1	0.015
	3-2	0.005
	3-4	0.021
/ D3Fmax	3-1	0.02
	3-2	0.002
	3-4	0.005

```
. kwallis D1Fmax, by(obtur)

Kruskal-Wallis equality-of-populations rank test
```

obtur	Obs	Rank sum
1	20	509.00
2	20	704.00
3	20	1089.50
4	20	937.50

```
  chi2(3) = 18.168
     Prob = 0.0004

  chi2(3) with ties = 19.810
               Prob = 0.0002

. kwallis D2Fmax, by(obtur)

Kruskal-Wallis equality-of-populations rank test
```

obtur	Obs	Rank sum
1	20	717.00
2	20	702.00
3	20	1070.50
4	20	750.50

```
  chi2(3) =  8.492
     Prob = 0.0369

  chi2(3) with ties = 15.907
               Prob = 0.0012

. kwallis D3Fmax, by(obtur)

Kruskal-Wallis equality-of-populations rank test
```

obtur	Obs	Rank sum
1	20	700.00
2	20	700.00
3	20	1066.00
4	20	774.00

```
  chi2(3) =  8.429
     Prob = 0.0379

  chi2(3) with ties = 23.534
               Prob = 0.0001
```

The Kruskal-Wallis test identified a statistically significant difference (P=0.00) in the means of maximal pain among the obturation groups across all post-filling treatment days. Obturation group 3 consistently exhibited the highest rank sum, while the lowest values were observed in obturation groups 1 and 2.

IMPACT ON OVERALL QUALITY OF LIFE

Based on the data presented and accompanying graphs (Pics.18, 19) detailing the impact on overall quality of life across each obturation group (on the first, second, and third days), we can draw the following conclusions:

```
. sum D1Foqol D2Foqol D3Foqol if obtur ==1

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
     D1Foqol |         20          .2     .615587          0          2
     D2Foqol |         20          .2     .615587          0          2
     D3Foqol |         20           0           0          0          0

. sum D1Foqol D2Foqol D3Foqol if obtur ==2

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
     D1Foqol |         20         .05    .2236068          0          1
     D2Foqol |         20           0           0          0          0
     D3Foqol |         20           0           0          0          0

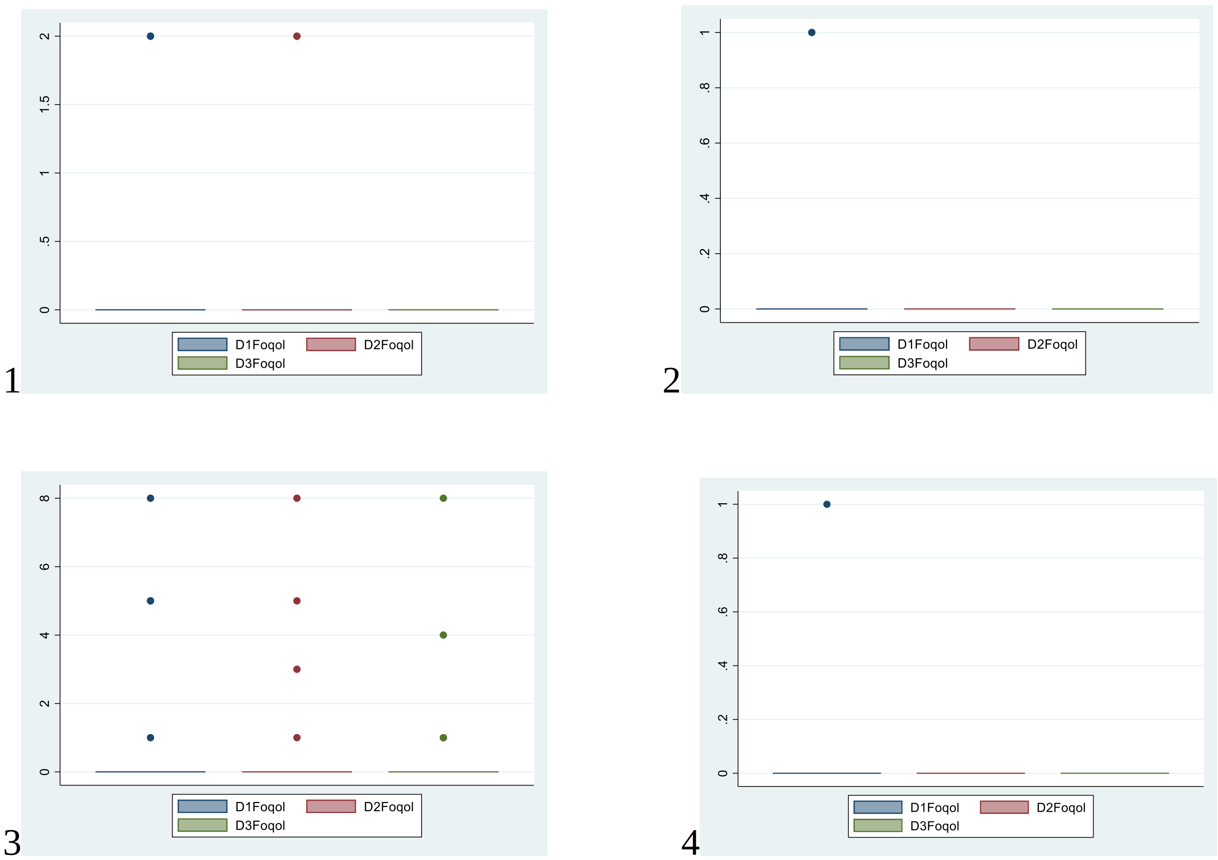
. sum D1Foqol D2Foqol D3Foqol if obtur ==3

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
     D1Foqol |         20         .95    2.258901          0          8
     D2Foqol |         20         .85    2.109502          0          8
     D3Foqol |         20          .7    1.949359          0          8

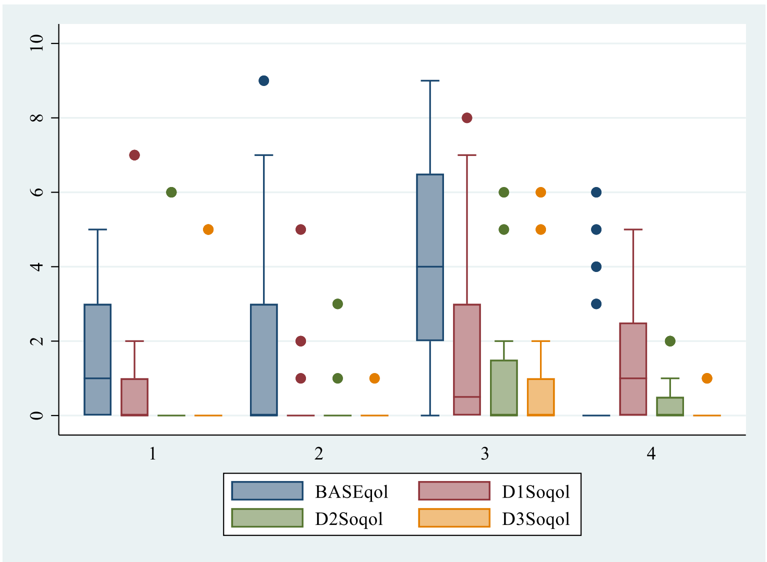
. sum D1Foqol D2Foqol D3Foqol if obtur ==4

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
     D1Foqol |         20         .05    .2236068          0          1
     D2Foqol |         20           0           0          0          0
     D3Foqol |         20           0           0          0          0
```

Pic.18 Impact on overall quality of life following filling treatment on the first, second and third day (D1Foqol, D2Foqol, D3Foqol) of each obturation group (1,2,3,4)



Pic. 19 Impact on overall quality of life prior to and following Shaping and Treatment



-on the first day after the filling stage of treatment obturation group 3 (AH_c) had the highest mean of impact on overall quality of life (0.95), while obturation groups 2 (BC_w) and 4 (AH_w) had the lowest mean of maximal pain level (0.05);

-on the second day after the filling stage of treatment obturation group 3 (AH_c) demonstrated the highest level of mean of impact on overall quality of life (0.85), while obturation groups 2 (BC_w) and 4 (AH_w) once more had the lowest mean. (0.00).

-on the third day after the filling stage of treatment obturation group 3 (AH_c) still had the highest mean of impact on overall quality of life (0.7) while no impact was discerned in the remaining groups.

Overall, obturation group 3 (AH_c) had the highest mean level of impact on overall quality of life at all stages of treatment and on each day compared to the other obturation groups. This may suggest that use of the traditional AH_c obturation technique is a less favorable option, as it may cause more intense pain.. Obturation groups 2 and 4 (BC_w, AH_w) had the lowest mean of impact on overall quality of life at all stages of treatment and on each day. This may suggest that use of these techniques can be beneficial.

The Tukey test was used to evaluate the differences between the obturation groups:

```
. pwmean D1Foqol, over(obtur) mcompare(tukey) effects

Pairwise comparisons of means with equal variances

Over: obtur

─────────────┬─────────────
             │   Number of
             │ comparisons
─────────────┼─────────────
       obtur │           6
─────────────┴─────────────

─────────────┬────────────────────────────────────────────────────────────
             │                            Tukey              Tukey
     D1Foqol │   Contrast   Std. err.      t    P>|t|     [95% conf. interval]
─────────────┼────────────────────────────────────────────────────────────
       obtur │
     2 vs 1  │       -.15    .3735498    -0.40   0.978    -1.131239    .8312395
     3 vs 1  │        .75    .3735498     2.01   0.194    -.2312395    1.731239
     4 vs 1  │       -.15    .3735498    -0.40   0.978    -1.131239    .8312395
     3 vs 2  │         .9    .3735498     2.41   0.084    -.0812395    1.881239
     4 vs 2  │   2.78e-17    .3735498     0.00   1.000    -.9812395    .9812395
     4 vs 3  │        -.9    .3735498    -2.41   0.084    -1.881239    .0812395
─────────────┴────────────────────────────────────────────────────────────

. pwmean D2Foqol, over(obtur) mcompare(tukey) effects

Pairwise comparisons of means with equal variances

Over: obtur

─────────────┬─────────────
             │   Number of
             │ comparisons
─────────────┼─────────────
       obtur │           6
─────────────┴─────────────

─────────────┬────────────────────────────────────────────────────────────
             │                            Tukey              Tukey
     D2Foqol │   Contrast   Std. err.      t    P>|t|     [95% conf. interval]
─────────────┼────────────────────────────────────────────────────────────
       obtur │
     2 vs 1  │        -.2    .3474531    -0.58   0.939    -1.112689    .7126888
     3 vs 1  │        .65    .3474531     1.87   0.249    -.2626888    1.562689
     4 vs 1  │        -.2    .3474531    -0.58   0.939    -1.112689    .7126888
     3 vs 2  │        .85    .3474531     2.45   0.077    -.0626888    1.762689
     4 vs 2  │          0    .3474531     0.00   1.000    -.9126888    .9126888
     4 vs 3  │       -.85    .3474531    -2.45   0.077    -1.762689    .0626888
─────────────┴────────────────────────────────────────────────────────────

. pwmean D3Foqol, over(obtur) mcompare(tukey) effects

Pairwise comparisons of means with equal variances

Over: obtur

─────────────┬─────────────
             │   Number of
             │ comparisons
─────────────┼─────────────
       obtur │           6
─────────────┴─────────────

─────────────┬────────────────────────────────────────────────────────────
             │                            Tukey              Tukey
     D3Foqol │   Contrast   Std. err.      t    P>|t|     [95% conf. interval]
─────────────┼────────────────────────────────────────────────────────────
       obtur │
     2 vs 1  │  -1.79e-16    .3082207    -0.00   1.000    -.8096331    .8096331
     3 vs 1  │         .7    .3082207     2.27   0.114    -.1096331    1.509633
     4 vs 1  │  -1.93e-16    .3082207    -0.00   1.000    -.8096331    .8096331
     3 vs 2  │         .7    .3082207     2.27   0.114    -.1096331    1.509633
     4 vs 2  │  -1.43e-17    .3082207    -0.00   1.000    -.8096331    .8096331
     4 vs 3  │        -.7    .3082207    -2.27   0.114    -1.509633    .1096331
─────────────┴────────────────────────────────────────────────────────────
```

This test did not reveal statistically significant differences in the impact on overall quality of life among the obturation groups on any post-filling day, underscoring that the obturation group does not significantly influence this particular variable.

```
. kwallis D1Foqol, by(obtur)

Kruskal-Wallis equality-of-populations rank test

  +------------------------+
  | obtur | Obs | Rank sum |
  |-------+-----+----------|
  |     1 |  20 |   810.00 |
  |     2 |  20 |   767.50 |
  |     3 |  20 |   895.00 |
  |     4 |  20 |   767.50 |
  +------------------------+

  chi2(3) =  1.003
     Prob = 0.8004

  chi2(3) with ties =  3.703
               Prob = 0.2953

. kwallis D2Foqol, by(obtur)

Kruskal-Wallis equality-of-populations rank test

  +------------------------+
  | obtur | Obs | Rank sum |
  |-------+-----+----------|
  |     1 |  20 |   828.00 |
  |     2 |  20 |   750.00 |
  |     3 |  20 |   912.00 |
  |     4 |  20 |   750.00 |
  +------------------------+

  chi2(3) =  1.660
     Prob = 0.6459

  chi2(3) with ties =  7.960
               Prob = 0.0469

. kwallis D3Foqol, by(obtur)

Kruskal-Wallis equality-of-populations rank test

  +------------------------+
  | obtur | Obs | Rank sum |
  |-------+-----+----------|
  |     1 |  20 |   770.00 |
  |     2 |  20 |   770.00 |
  |     3 |  20 |   930.00 |
  |     4 |  20 |   770.00 |
  +------------------------+

  chi2(3) =  1.778
     Prob = 0.6198

  chi2(3) with ties = 12.464
               Prob = 0.0060
```

The Kruskal-Wallis test revealed a statistically significant variation in the means of the impact on overall quality of life among the obturation groups on both the second

(P=0.0469) and third days (P=0.006) post-filling treatment. Obturation group 3 consistently exhibited the highest rank sum score on these days, while the lowest scores were observed in obturation groups 2 and 4.

ANALGESIC INTAKE

Based on the data presented and the accompanying graphs (Pic. 20,21) detailing angalgesic intake post-filling treatment across each obturation group (on the first, second, and third days), we can draw the following conclusions:

. sum D1Fai D2Fai D3Fai if obtur ==1

Variable	Obs	Mean	Std. dev.	Min	Max
D1Fai	20	0	0	0	0
D2Fai	20	0	0	0	0
D3Fai	20	0	0	0	0

. sum D1Fai D2Fai D3Fai if obtur ==2

Variable	Obs	Mean	Std. dev.	Min	Max
D1Fai	20	.2	.5231484	0	2
D2Fai	20	0	0	0	0
D3Fai	20	0	0	0	0

. sum D1Fai D2Fai D3Fai if obtur ==3

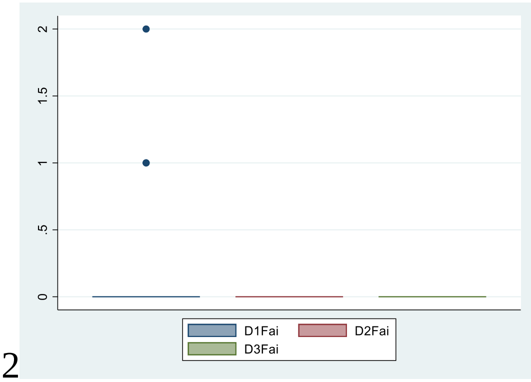
Variable	Obs	Mean	Std. dev.	Min	Max
D1Fai	20	.35	.5871429	0	2
D2Fai	20	.15	.4893605	0	2
D3Fai	20	.2	.5231484	0	2

. sum D1Fai D2Fai D3Fai if obtur ==4

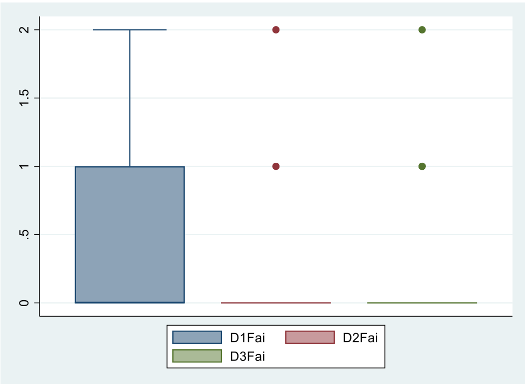
Variable	Obs	Mean	Std. dev.	Min	Max
D1Fai	20	.1	.3077935	0	1
D2Fai	20	0	0	0	0
D3Fai	20	0	0	0	0

Pic. 20 Maximal pain levels following filling treatment on the first, second and third day (/ D1Fai, / D2Fai, / D3Fai) of each obturation group (1, 2, 3, 4)

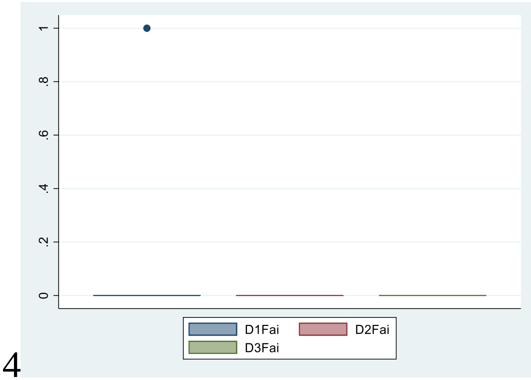
1



2

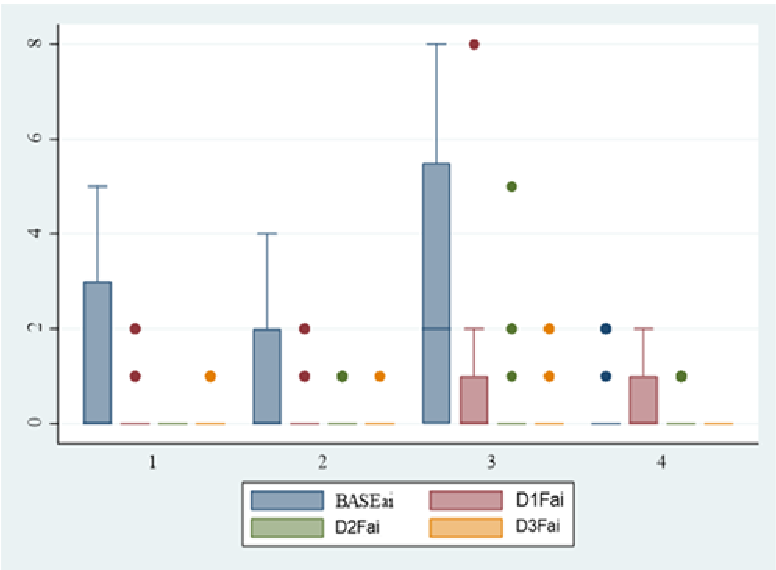


3



4

Pic. 21 Analgesic intake prior to and following shaping and treatment



-on the first day after the filling stage of treatment obturation group 3 (AH_c) had the highest mean of analgesic intake (0.35), while obturation group 1 (BC_c) had the lowest mean of this variable (0);

-on the second day after the filling stage of treatment the mean of analgesic intake in obturation group 3 (AH_c) was 0.15. No analgesic intake was recorded in the remaining groups.

-on the third day after the filling stage of treatment obturation group 3 (AH_c) still had the mean of analgesic intake (0.2). Again, no analgesic intake was recorded in the remaining groups..

Overal,l obturation group 3 (AH_c) demonstated the highest mean level of analgesic intake on each day. This might suggest they experienced more intense pain and therefore required analgesics.

The Tukey test was used to evaluate the differences between the obturation groups:

```
. pwmean D1Fai, over(obtur) mcompare(tukey) effects
```

Pairwise comparisons of means with equal variances

Over: obtur

	Number of comparisons
obtur	6

D1Fai	Contrast	Std. err.	Tukey t	Tukey P>|t|	Tukey [95% conf.	interval]
obtur						
2 vs 1	.2	.1335251	1.50	0.444	-.1507432	.5507432
3 vs 1	.35	.1335251	2.62	0.051	-.0007432	.7007432
4 vs 1	.1	.1335251	0.75	0.877	-.2507432	.4507432
3 vs 2	.15	.1335251	1.12	0.676	-.2007432	.5007432
4 vs 2	-.1	.1335251	-0.75	0.877	-.4507432	.2507432
4 vs 3	-.25	.1335251	-1.87	0.249	-.6007432	.1007432

```
. pwmean D2Fai, over(obtur) mcompare(tukey) effects
```

Pairwise comparisons of means with equal variances

Over: obtur

	Number of comparisons
obtur	6

D2Fai	Contrast	Std. err.	Tukey t	Tukey P>|t|	Tukey [95% conf.	interval]
obtur						
2 vs 1	-1.43e-17	.0773747	-0.00	1.000	-.2032476	.2032476
3 vs 1	.15	.0773747	1.94	0.221	-.0532476	.3532476
4 vs 1	-2.15e-17	.0773747	-0.00	1.000	-.2032476	.2032476
3 vs 2	.15	.0773747	1.94	0.221	-.0532476	.3532476
4 vs 2	-7.17e-18	.0773747	-0.00	1.000	-.2032476	.2032476
4 vs 3	-.15	.0773747	-1.94	0.221	-.3532476	.0532476

```
. pwmean D3Fai, over(obtur) mcompare(tukey) effects
```

Pairwise comparisons of means with equal variances

Over: obtur

	Number of comparisons
obtur	6

D3Fai	Contrast	Std. err.	Tukey t	Tukey P>|t|	Tukey [95% conf.	interval]
obtur						
2 vs 1	1.49e-16	.082717	0.00	1.000	-.2172808	.2172808
3 vs 1	.2	.082717	2.42	0.082	-.0172808	.4172808
4 vs 1	1.45e-16	.082717	0.00	1.000	-.2172808	.2172808
3 vs 2	.2	.082717	2.42	0.082	-.0172808	.4172808
4 vs 2	-3.58e-18	.082717	-0.00	1.000	-.2172808	.2172808
4 vs 3	-.2	.082717	-2.42	0.082	-.4172808	.0172808

This test revealed statistically significant differences in analgesic intake (P=0.05) solely between obturation groups 1 (BC_c) and 3 (AH_c), and this was evident only on the first day post-filling treatment. This underscores the influence of these obturation techniques on analgesic intake.

```
. kwallis D1Fai, by(obtur)

Kruskal-Wallis equality-of-populations rank test
```

obtur	Obs	Rank sum
1	20	700.00
2	20	822.50
3	20	939.50
4	20	778.00

```
  chi2(3) =  2.782
     Prob = 0.4264

  chi2(3) with ties =  7.794
              Prob = 0.0505

. kwallis D2Fai, by(obtur)

Kruskal-Wallis equality-of-populations rank test
```

obtur	Obs	Rank sum
1	20	790.00
2	20	790.00
3	20	870.00
4	20	790.00

```
  chi2(3) =  0.444
     Prob = 0.9309

  chi2(3) with ties =  6.076
              Prob = 0.1080

. kwallis D3Fai, by(obtur)

Kruskal-Wallis equality-of-populations rank test
```

obtur	Obs	Rank sum
1	20	780.00
2	20	780.00
3	20	900.00
4	20	780.00

```
  chi2(3) =  1.000
     Prob = 0.8013

  chi2(3) with ties =  9.231
              Prob = 0.0264
```

The Kruskal-Wallis test revealed a statistically significant variation in the means of analgesic intake among the obturation groups on both the first (P=0.05) and third day

(P=0.02) post-filling treatment. Obturation group 3 again exhibited the highest rank sum score on these days.

DETAILED PAIN VARIABLES

The impact on various patient functions, such as eating, daily activities, speaking, sleeping, and social interactions, was also assessed across the different obturation groups. Obturation group 3 (AH_c) registered the most significant impact on eating at all observed time points both pre and post both treatment stages. This impact level diminished daily, with the decrease reaching statistical significance as confirmed by the Friedman test (P=0.00) (Pic.22)

```
. summarize BASEeating D1Seating D2Seating D3Seating D1Feating D2Feating D3Feating

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
  BASEeating |         80      2.9625    3.231349          0         10
   D1Seating |         80      2.4875    2.765034          0          8
   D2Seating |         80      1.3375    2.215845          0          8
   D3Seating |         80        .775    1.713498          0          8
   D1Feating |         80          .8    1.664218          0          9
-------------+---------------------------------------------------------
   D2Feating |         80       .4375    1.421746          0          9
   D3Feating |         80       .4125    1.393418          0          9
```

```
. friedman BASEeating D1Seating D2Seating D3Seating D1Feating D2Feating D3Feating

Friedman = 181.8278
Kendall =    0.3288
P-value =    0.0000
```

```
. summarize BASEeating D1Seating D2Seating D3Seating D1Feating D2Feating D3Feating if obtur==1
```

Variable	Obs	Mean	Std. dev.	Min	Max
BASEeating	20	2.6	2.392972	0	8
D1Seating	20	2.7	2.556725	0	8
D2Seating	20	1.3	2.473012	0	8
D3Seating	20	1	2.15211	0	7
D1Feating	20	.4	.680557	0	2
D2Feating	20	.3	.6569467	0	2
D3Feating	20	.3	.6569467	0	2

```
. summarize BASEeating D1Seating D2Seating D3Seating D1Feating D2Feating D3Feating if obtur==2
```

Variable	Obs	Mean	Std. dev.	Min	Max
BASEeating	20	2.35	3.391553	0	10
D1Seating	20	.7	1.894591	0	7
D2Seating	20	.45	1.190975	0	5
D3Seating	20	.1	.4472136	0	2
D1Feating	20	.35	.6708204	0	2
D2Feating	20	0	0	0	0
D3Feating	20	0	0	0	0

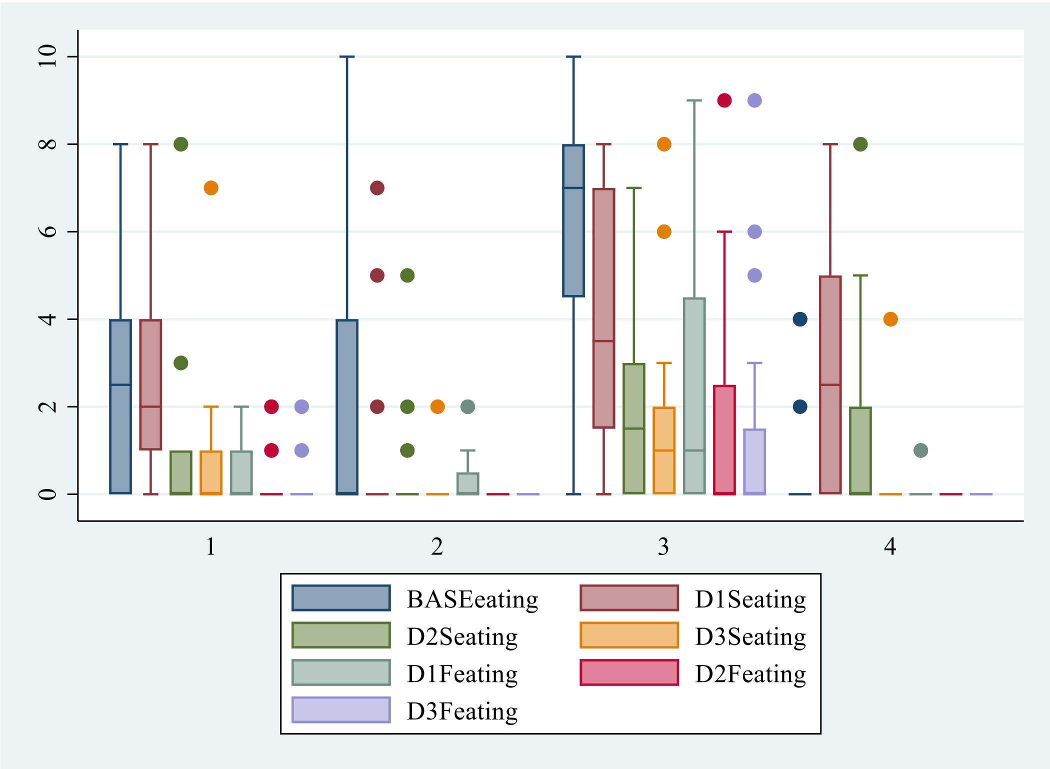
```
. summarize BASEeating D1Seating D2Seating D3Seating D1Feating D2Feating D3Feating if obtur==3
```

Variable	Obs	Mean	Std. dev.	Min	Max
BASEeating	20	6.2	2.64774	0	10
D1Seating	20	3.9	2.900091	0	8
D2Seating	20	1.95	2.114486	0	7
D3Seating	20	1.6	2.112619	0	8
D1Feating	20	2.3	2.696977	0	9
D2Feating	20	1.45	2.543826	0	9
D3Feating	20	1.35	2.518876	0	9

```
. summarize BASEeating D1Seating D2Seating D3Seating D1Feating D2Feating D3Feating if obtur==4
```

Variable	Obs	Mean	Std. dev.	Min	Max
BASEeating	20	.7	1.49032	0	4
D1Seating	20	2.65	2.777257	0	8
D2Seating	20	1.65	2.661124	0	8
D3Seating	20	.4	1.231174	0	4
D1Feating	20	.15	.3663475	0	1
D2Feating	20	0	0	0	0
D3Feating	20	0	0	0	0

Pic. 22 Impact on eating prior to and following shaping and filling treatment



The analysis of the impact on daily functions, particularly the ability to carry out everyday activities, was documented at baseline and predominantly during the first two days post-shaping treatment. The most pronounced impact was observed in patients from obturation group 3 (AH_c), and this persisted after the filling treatment as well. There was a consistent decrease in this impact level each day, which was statistically significant as confirmed by the Friedman test (P=0.0026). In groups 2 (BC_w) and 4 (AH_w), no impact on daily function was observed from the third day following shaping treatment onwards and until the end of the observation period (Pic.23)

. summarize BASEdaily_funct D1Sdaily_funct D2Sdaily_funct D3Sdaily_funct D1Fdaily_funct D2Fdaily_funct D3Fdaily_funct

Variable	Obs	Mean	Std. dev.	Min	Max
BASEdaily_~t	80	2.075	2.699156	0	9
D1Sdaily_f~t	80	1.6625	2.354332	0	8
D2Sdaily_f~t	80	.575	1.651811	0	8
D3Sdaily_f~t	80	.4	1.29849	0	6
D1Fdaily_f~t	80	.4	1.327413	0	9
D2Fdaily_f~t	80	.275	1.168955	0	9
D3Fdaily_f~t	80	.1875	1.103433	0	9

. friedman BASEdaily_funct D1Sdaily_funct D2Sdaily_funct D3Sdaily_funct D1Fdaily_funct D2Fdaily_funct D3Fdaily_funct

```
Friedman = 118.6528
Kendall =    0.2146
P-value =    0.0026
```

. summarize BASEdaily_funct D1Sdaily_funct D2Sdaily_funct D3Sdaily_funct D1Fdaily_funct D2Fdaily_funct D3Fdaily_funct if obtur==1

Variable	Obs	Mean	Std. dev.	Min	Max
BASEdaily_~t	20	2.4	2.010499	0	6
D1Sdaily_f~t	20	2.1	2.573141	0	8
D2Sdaily_f~t	20	.8	2.462348	0	8
D3Sdaily_f~t	20	.6	1.846761	0	6
D1Fdaily_f~t	20	.3	.6569467	0	2
D2Fdaily_f~t	20	.2	.615587	0	2
D3Fdaily_f~t	20	0	0	0	0

. summarize BASEdaily_funct D1Sdaily_funct D2Sdaily_funct D3Sdaily_funct D1Fdaily_funct D2Fdaily_funct D3Fdaily_funct if obtur==2

Variable	Obs	Mean	Std. dev.	Min	Max
BASEdaily_~t	20	1.4	2.521487	0	8
D1Sdaily_f~t	20	.7	1.49032	0	5
D2Sdaily_f~t	20	.1	.4472136	0	2
D3Sdaily_f~t	20	0	0	0	0
D1Fdaily_f~t	20	0	0	0	0
D2Fdaily_f~t	20	0	0	0	0
D3Fdaily_f~t	20	0	0	0	0

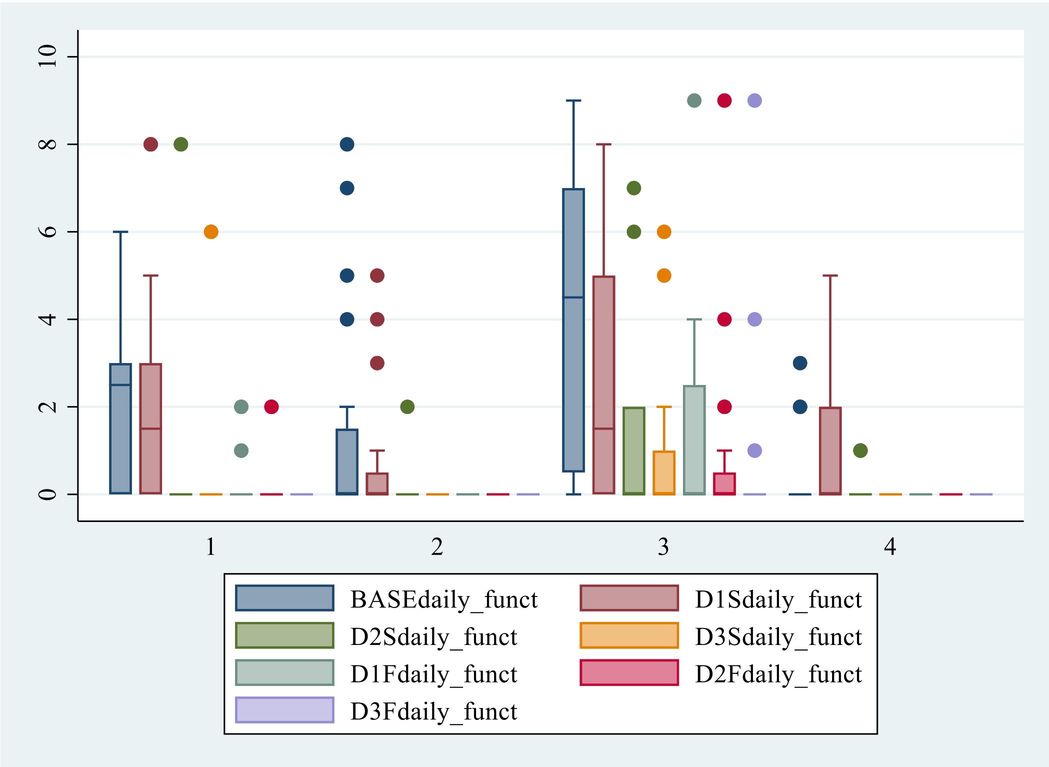
. summarize BASEdaily_funct D1Sdaily_funct D2Sdaily_funct D3Sdaily_funct D1Fdaily_funct D2Fdaily_funct D3Fdaily_funct if obtur==3

Variable	Obs	Mean	Std. dev.	Min	Max
BASEdaily_~t	20	4.15	3.297128	0	9
D1Sdaily_f~t	20	2.55	2.818641	0	8
D2Sdaily_f~t	20	1.2	2.015728	0	7
D3Sdaily_f~t	20	1	1.685854	0	6
D1Fdaily_f~t	20	1.3	2.386365	0	9
D2Fdaily_f~t	20	.9	2.174009	0	9
D3Fdaily_f~t	20	.75	2.149051	0	9

. summarize BASEdaily_funct D1Sdaily_funct D2Sdaily_funct D3Sdaily_funct D1Fdaily_funct D2Fdaily_funct D3Fdaily_funct if obtur==4

Variable	Obs	Mean	Std. dev.	Min	Max
BASEdaily_~t	20	.35	.875094	0	3
D1Sdaily_f~t	20	1.3	2.028741	0	5
D2Sdaily_f~t	20	.2	.4103913	0	1
D3Sdaily_f~t	20	0	0	0	0
D1Fdaily_f~t	20	0	0	0	0
D2Fdaily_f~t	20	0	0	0	0
D3Fdaily_f~t	20	0	0	0	0

Pic. 23 Impact on daily function prior to and following shaping and filling treatment



The analysis of the impact on speaking ability was documented at baseline and on the first day following shaping treatment, showing a statistically significant decrease thereafter (P=0.0028). The most marked impact on speaking ability was observed among patients in obturation group 3 (AH_c), and this persisted following the filling procedure. For patients in groups 2 (BC_w) and 4 (AH_w), no detrimental effect on speaking ability was recorded after the filling treatment. (Pic. 24).

```
. summarize BASEspeaking D1Sspeaking D2Sspeaking D3Sspeaking D1Fspeaking D2Fspeaking D3Fspeaking
```

Variable	Obs	Mean	Std. dev.	Min	Max
BASEspeaking	80	1.3875	2.498069	0	8
D1Sspeaking	80	1.1625	2.08335	0	8
D2Sspeaking	80	.375	1.246514	0	7
D3Sspeaking	80	.25	1	0	6
D1Fspeaking	80	.4625	1.483613	0	9
D2Fspeaking	80	.2875	1.160464	0	9
D3Fspeaking	80	.1875	1.0445	0	9

```
. friedman BASEspeaking D1Sspeaking D2Sspeaking D3Sspeaking D1Fspeaking D2Fspeaking D3Fspeaking

Friedman = 118.2943
Kendall =    0.2139
P-value =    0.0028
```

```
. summarize BASEspeaking D1Sspeaking D2Sspeaking D3Sspeaking D1Fspeaking D2Fspeaking D3Fspeaking if obtur==1
```

Variable	Obs	Mean	Std. dev.	Min	Max
BASEspeaking	20	1.5	2.259483	0	6
D1Sspeaking	20	1.5	1.960129	0	6
D2Sspeaking	20	0	0	0	0
D3Sspeaking	20	0	0	0	0
D1Fspeaking	20	.3	.9233805	0	3
D2Fspeaking	20	.2	.615587	0	2
D3Fspeaking	20	.1	.3077935	0	1

```
. summarize BASEspeaking D1Sspeaking D2Sspeaking D3Sspeaking D1Fspeaking D2Fspeaking D3Fspeaking if obtur==2
```

Variable	Obs	Mean	Std. dev.	Min	Max
BASEspeaking	20	1.1	2.712544	0	8
D1Sspeaking	20	.45	1.394538	0	5
D2Sspeaking	20	.2	.6958524	0	3
D3Sspeaking	20	0	0	0	0
D1Fspeaking	20	0	0	0	0
D2Fspeaking	20	0	0	0	0
D3Fspeaking	20	0	0	0	0

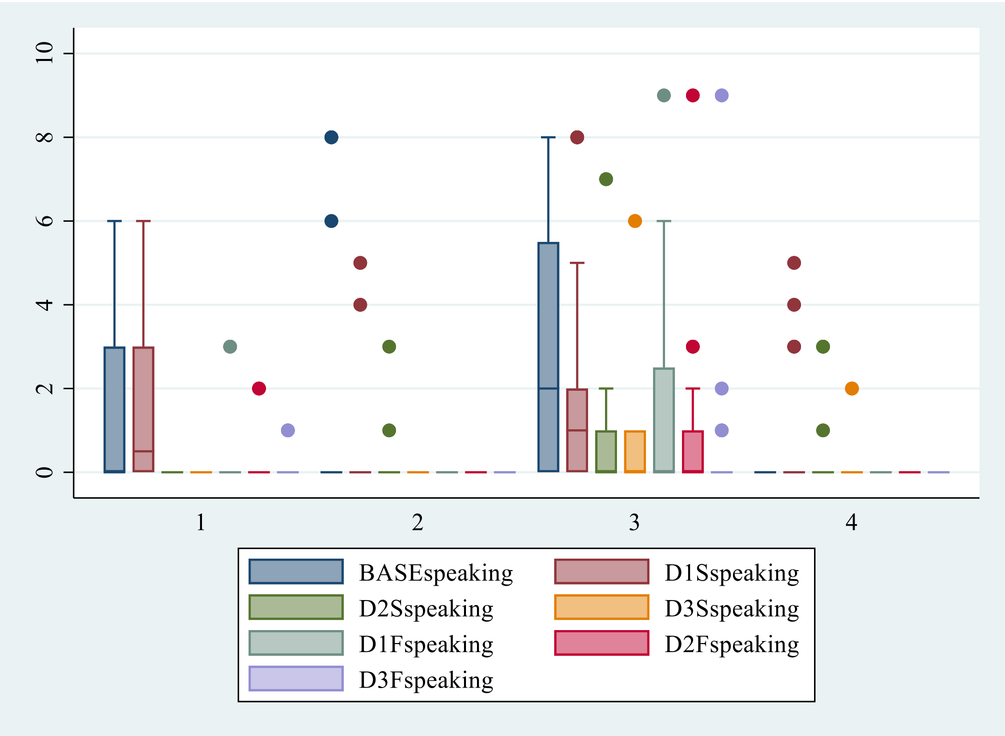
```
. summarize BASEspeaking D1Sspeaking D2Sspeaking D3Sspeaking D1Fspeaking D2Fspeaking D3Fspeaking if obtur==3
```

Variable	Obs	Mean	Std. dev.	Min	Max
BASEspeaking	20	2.95	2.964261	0	8
D1Sspeaking	20	1.95	2.874113	0	8
D2Sspeaking	20	.95	2.139233	0	7
D3Sspeaking	20	.8	1.823819	0	6
D1Fspeaking	20	1.55	2.564433	0	9
D2Fspeaking	20	.95	2.139233	0	9
D3Fspeaking	20	.65	2.033276	0	9

```
. summarize BASEspeaking D1Sspeaking D2Sspeaking D3Sspeaking D1Fspeaking D2Fspeaking D3Fspeaking if obtur==4
```

Variable	Obs	Mean	Std. dev.	Min	Max
BASEspeaking	20	0	0	0	0
D1Sspeaking	20	.75	1.585294	0	5
D2Sspeaking	20	.35	.933302	0	3
D3Sspeaking	20	.2	.615587	0	2
D1Fspeaking	20	0	0	0	0
D2Fspeaking	20	0	0	0	0
D3Fspeaking	20	0	0	0	0

Pic.24 Impact on speaking prior to and following shaping and filling treatment



The analysis of the impact on sleeping ability was documented at baseline, with a noticeable change on the first day following shaping treatment, showing a statistically significant reduction in this impact thereafter (P=0.0028). The most marked impact on their ability to sleep was observed among patients in obturation group 3 (AH_c) and this persisted after the filling process. For patients in groups 2 (BC_w) and 4 (AH_w), no impact on their sleeping patterns was observed post-filling (Pic 25).

. summarize BASEsleeping D1Ssleeping D2Ssleeping D3Ssleeping D1Fsleeping D2Fsleeping D3Fsleeping

Variable	Obs	Mean	Std. dev.	Min	Max
BASEsleeping	80	2.075	2.889418	0	10
D1Ssleeping	80	.8875	1.993621	0	8
D2Ssleeping	80	.4875	1.44952	0	7
D3Ssleeping	80	.2875	1.203305	0	7
D1Fsleeping	80	.3875	1.571049	0	9
D2Fsleeping	80	.225	1.221899	0	9
D3Fsleeping	80	.2125	1.187421	0	9

. summarize BASEsleeping D1Ssleeping D2Ssleeping D3Ssleeping D1Fsleeping D2Fsleeping D3Fsleeping if obtur==1

Variable	Obs	Mean	Std. dev.	Min	Max
BASEsleeping	20	1.7	2.29645	0	7
D1Ssleeping	20	1.3	2.430075	0	8
D2Ssleeping	20	.6	1.846761	0	6
D3Ssleeping	20	.4	1.231174	0	4
D1Fsleeping	20	0	0	0	0
D2Fsleeping	20	0	0	0	0
D3Fsleeping	20	0	0	0	0

. summarize BASEsleeping D1Ssleeping D2Ssleeping D3Ssleeping D1Fsleeping D2Fsleeping D3Fsleeping if obtur==2

Variable	Obs	Mean	Std. dev.	Min	Max
BASEsleeping	20	1.9	3.024462	0	10
D1Ssleeping	20	.4	1.569445	0	7
D2Ssleeping	20	.3	.8013147	0	3
D3Ssleeping	20	0	0	0	0
D1Fsleeping	20	0	0	0	0
D2Fsleeping	20	0	0	0	0
D3Fsleeping	20	0	0	0	0

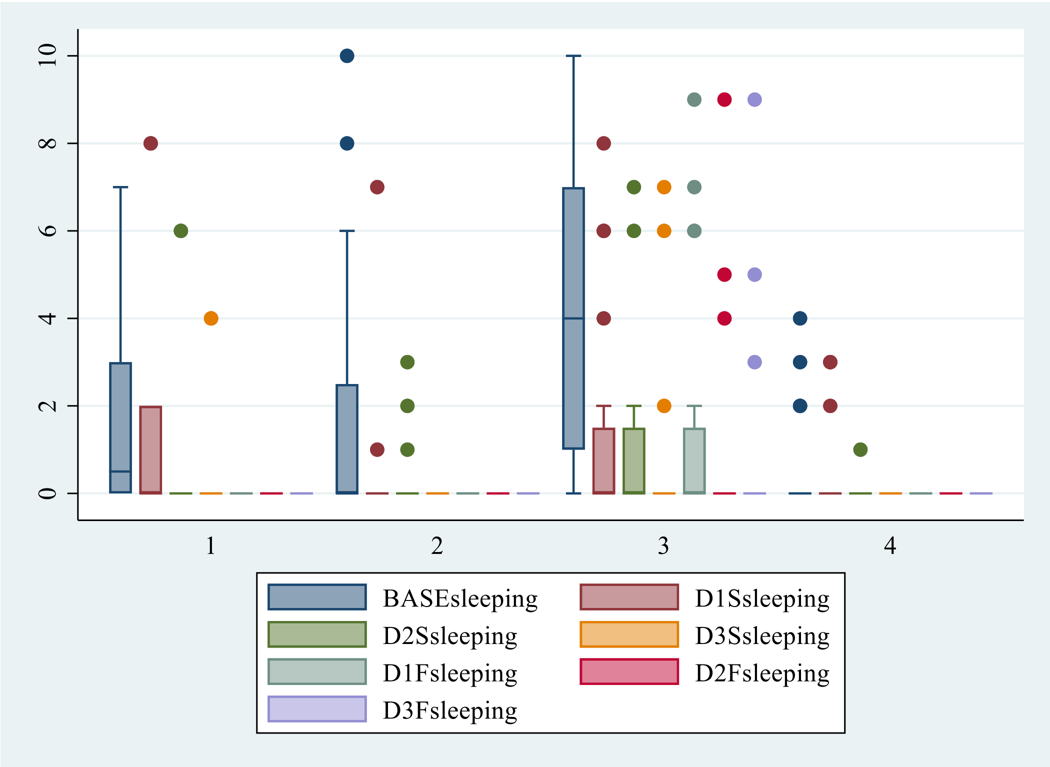
. summarize BASEsleeping D1Ssleeping D2Ssleeping D3Ssleeping D1Fsleeping D2Fsleeping D3Fsleeping if obtur==3

Variable	Obs	Mean	Std. dev.	Min	Max
BASEsleeping	20	4.15	3.422449	0	10
D1Ssleeping	20	1.45	2.48098	0	8
D2Ssleeping	20	1	2.026145	0	7
D3Ssleeping	20	.75	2.022895	0	7
D1Fsleeping	20	1.55	2.892367	0	9
D2Fsleeping	20	.9	2.35975	0	9
D3Fsleeping	20	.85	2.300458	0	9

. summarize BASEsleeping D1Ssleeping D2Ssleeping D3Ssleeping D1Fsleeping D2Fsleeping D3Fsleeping if obtur==4

Variable	Obs	Mean	Std. dev.	Min	Max
BASEsleeping	20	.55	1.190975	0	4
D1Ssleeping	20	.4	.9947229	0	3
D2Ssleeping	20	.05	.2236068	0	1
D3Ssleeping	20	0	0	0	0
D1Fsleeping	20	0	0	0	0
D2Fsleeping	20	0	0	0	0
D3Fsleeping	20	0	0	0	0

Pic. 25 Impact on sleeping prior to and following shaping and filling treatment



The analysis of the impact on social-related abilities was documented at baseline and the day following the treatment, showing a statistically significant decrease thereafter (P=0.0028). The most significant impact on social interactions was observed in patients belonging to obturation group 3 (AH_c), and this persisted post-filling too. Patients in groups 2 (BC_w) and 4 (AH_w) experienced no impact in their social-related abilities following the filling stage of the treatment (Pic. 26).

```
. summarize BASEsocial_relat D1Ssocial_relat D2Ssocial_relat D3Ssocial_relat D1Fsocial_relat D2Fsocial_relat D3Fsocial_relat

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
BASEsocial~t |         80      1.4875    2.545752          0          9
D1Ssocial_~t |         80         .75    1.845281          0          8
D2Ssocial_~t |         80        .275      1.0185          0          7
D3Ssocial_~t |         80       .2125    .9638235          0          6
D1Fsocial_~t |         80       .3625    1.361717          0          9
-------------+---------------------------------------------------------
D2Fsocial_~t |         80        .275    1.221899          0          9
D3Fsocial_~t |         80       .2125    1.098834          0          9
```

```
. friedman BASEsocial_relat D1Ssocial_relat D2Ssocial_relat D3Ssocial_relat D1Fsocial_relat D2Fsocial_relat D3Fsocial_relat

Friedman =  98.7622
Kendall =    0.1786
P-value =    0.0656
```

```
. summarize BASEsocial_relat D1Ssocial_relat D2Ssocial_relat D3Ssocial_relat D1Fsocial_relat D2Fsocial_relat D3Fsocial_relat if obtur==1

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
BASEsocial~t |         20         1.2    1.704483          0          5
D1Ssocial_~t |         20          .3    .6569467          0          2
D2Ssocial_~t |         20           0           0          0          0
D3Ssocial_~t |         20           0           0          0          0
D1Fsocial_~t |         20          .3    .9233805          0          3
-------------+---------------------------------------------------------
D2Fsocial_~t |         20          .3    .9233805          0          3
D3Fsocial_~t |         20          .2     .615587          0          2

. summarize BASEsocial_relat D1Ssocial_relat D2Ssocial_relat D3Ssocial_relat D1Fsocial_relat D2Fsocial_relat D3Fsocial_relat if obtur==2

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
BASEsocial~t |         20         1.5    3.103479          0          8
D1Ssocial_~t |         20          .6    1.846761          0          6
D2Ssocial_~t |         20          .2     .615587          0          2
D3Ssocial_~t |         20         .05    .2236068          0          1
D1Fsocial_~t |         20           0           0          0          0
-------------+---------------------------------------------------------
D2Fsocial_~t |         20           0           0          0          0
D3Fsocial_~t |         20           0           0          0          0

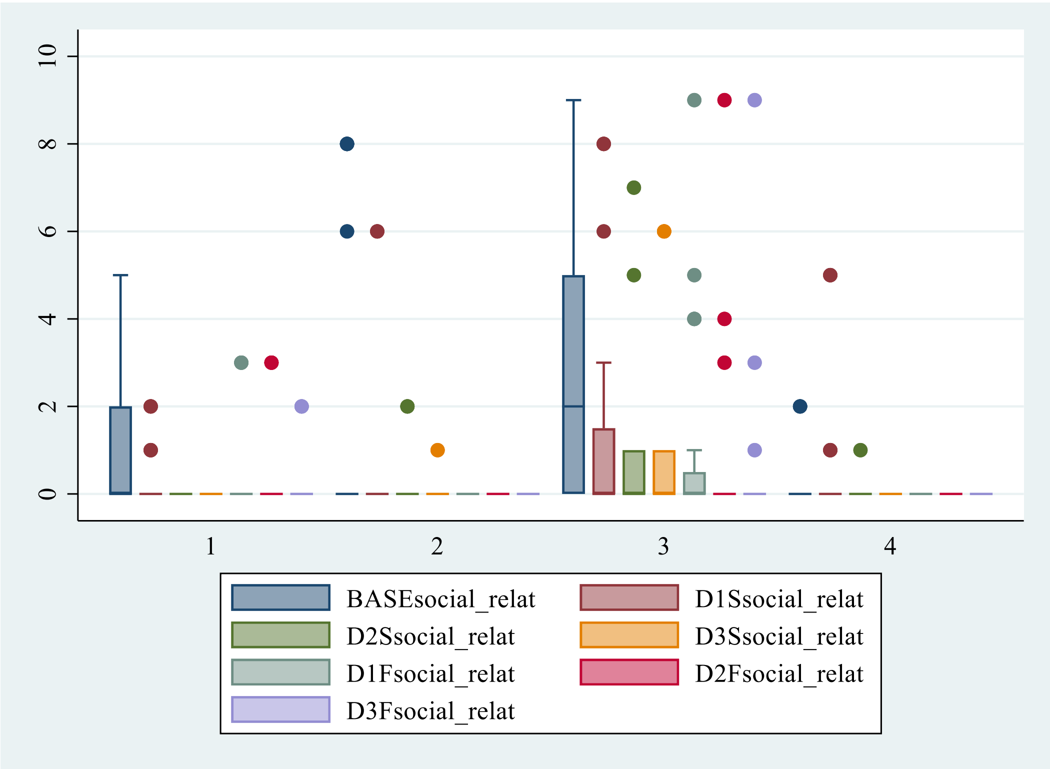
. summarize BASEsocial_relat D1Ssocial_relat D2Ssocial_relat D3Ssocial_relat D1Fsocial_relat D2Fsocial_relat D3Fsocial_relat if obtur==3

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
BASEsocial~t |         20        3.05    3.103055          0          9
D1Ssocial_~t |         20         1.5     2.66557          0          8
D2Ssocial_~t |         20         .85    1.843195          0          7
D3Ssocial_~t |         20          .8    1.823819          0          6
D1Fsocial_~t |         20        1.15    2.433862          0          9
-------------+---------------------------------------------------------
D2Fsocial_~t |         20          .8    2.214783          0          9
D3Fsocial_~t |         20         .65    2.084403          0          9

. summarize BASEsocial_relat D1Ssocial_relat D2Ssocial_relat D3Ssocial_relat D1Fsocial_relat D2Fsocial_relat D3Fsocial_relat if obtur==4

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
BASEsocial~t |         20          .2     .615587          0          2
D1Ssocial_~t |         20          .6    1.535544          0          5
D2Ssocial_~t |         20         .05    .2236068          0          1
D3Ssocial_~t |         20           0           0          0          0
D1Fsocial_~t |         20           0           0          0          0
-------------+---------------------------------------------------------
D2Fsocial_~t |         20           0           0          0          0
D3Fsocial_~t |         20           0           0          0          0
```

Pic.26 Impact on social relations prior to and following shaping and filling treatment



DISCUSSION

This study aimed to examine and compare the pre-operative clinical conditions, the influence on overall quality of life, analgesic intake, and postoperative pain following both warm and cold filling techniques using bioceramic and resin-based sealers.

Arias et al. [37] found that a decrease in postoperative pain (POP) is linked to patients who did not have pre-operative pain, those with single-rooted teeth, those with LEO, and those without occlusal contacts. Furthermore, POP tends to persist longer in older patients, especially women. Silva et al. [38] also concluded that the female gender correlates with heightened POP.

According to the results of our study, age and positive percussion significantly influenced the maximal pain level before treatment ($P<0.05$). Patients over the age of 50 are 6.11 times more likely to experience a higher pain level. Additionally, positive percussion increases the likelihood of experiencing the highest pain level by 6.82 times. On the first day post-treatment, having a LEO greater than 2 mm increases the likelihood of experiencing the highest level by 3.79 times ($P=0.016$). By the second day post-treatment, patients who underwent occlusal adjustment were 4.83 times more likely to have postoperative pain.

Our study determined that age and positive percussion influence the impact on overall quality of life prior to treatment. Patients over the age of 50 are 4.52 times more likely to experience a heightened impact on their quality of life ($P<0.05$). Positive percussion increases the likelihood of experiencing the highest level impact on overall quality of life by 5.76 times compared to combined scores ($P<0.05$). The impacts of occlusal adjustment and LEO on overall quality of life on the second day post-treatment were not significant ($p>0.05$). Occlusal adjustment had a considerable influence on the third day, increasing the impact by 6.11 times (P=0.008).

The influence of occlusal adjustment on the level of analgesic intake on the first day following shaping treatment is significant (P=0.019), increasing it 5.34-fold. The influence of occlusal adjustment on the level of analgesic intake is significant (P=0.049), increasing it in 4.92-fold. The influence of occlusal adjustment on the level of analgesic intake on the third day after the shaping treatment is significant (P=0.002), increasing it 12.87-fold.

Comparing maximal pain levels following shaping and filling interventions on the first, second, third days revealed that the shaping intervention caused a higher level of pain relative to the filling intervention on each of the three days. This may indicate that the first step of the treatment is more intense and may result in patients experiencing increased postoperative pain.

We observed no correlation between the pain level prior to treatment and following filling intervention.

According to the results of our study, LEO and age have significantly influence the level of maximal pain on the first day following filling intervention.

(P<0.05). LEO less than 2 mm increases the likelihood of having the highest level of pain when compared with all combined pain scores in 7.826 times (P=0.001). For patients in the 40-49 year age group, the likelihood of a higher pain level, compared with all combined pain scores, increases 0.351-fold (P=0.045). For patients in the 60-69 year age group, the likelihood of a higher pain level increases 0.324-fold (P=0.04).

Thus, regarding the impact of pre-operative and clinical factors on post-operative pain (POP), our findings align partially in terms of variables like age and LEO. However, our analysis suggests that other variables do not significantly contribute to the development of POP, diverging from conclusions drawn in previously published studies. [38, 39].

Overall, obturation groups 1 and 2 (BC_c, BC_w) exhibited a lower mean level of pain at all stages of treatment and on each day when compared with other obturation groups. This may suggest the potential benefits of using a bioceramic sealer. Obturation groups 3 and 4 (AH_c, AH_w) exhibited the highest mean level of pain at all stages of treatment and on each day. This may suggest that these groups experienced more intense pain.

Overall, obturation group 3 (AH_c) exhibited the highest mean level of impact on overall quality of life and analgesic intake, the greatest impact on eating, speaking, social related abilities and daily functions at all stages of treatment and on each day when compared with the other obturation groups. This may suggest that the use of the AH_c traditional obturation technique is a less favorable option, as it may cause more intense pain. Obturation groups 2 and 4 (BC_w, AH_w) exhibited the lowest mean of the aforementioned variables at all stages of treatment and on each day. This may suggest that these techniques produce more favorable outcomes.

In terms of comparing various filling techniques and endodontic sealers, our results are not directly comparable with previous studies, since there exists no study that has investigated both filling techniques and both types of sealers within a single research project [40, 41, 42]. This underscores the impact of our research within the professional field.

CONCLUSION

Within the limitations of this study, the authors present a unique investigation encompassing a complex and broad analysis of pre-operative and clinical variables and their influence on postoperative pain (POP), overall and specific quality of life metrics, and analgesic intake over a period of time following both treatment stages. Two distinct filling techniques, along with two types of endodontic sealers were considered. An enhancement to this research could involve the inclusion of carrier-based systems in the comparison groups, as well as expanding the sample size by incorporating a larger number of patient participants.

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Key words

Postoperative pain, bioceramic sealer, root canal filling, endodontics

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