Predicting Pain After Tooth Extraction: Pain Prediction Index

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Aims: To identify relevant variables that may predict pain after routine extraction of erupted teeth, to construct a Pain Prediction Index (PPI) based on these variables, and to verify how these variables are related by using valid structural equation modeling (ie, path analysis). **Methods:** This study was designed as an observational prospective study for postoperative memory of pain after dental extraction of erupted teeth. Data from a total of 781 surgical procedures related to dental extractions were included. Pain was self-reported by the patients and was evaluated by a verbal category scale (VCS) on the seventh postoperative day. The database was searched for predictive variables that were significantly ($P < .05$) associated with postoperative pain. **Results:** Pain was scored by patients as none in 65.4% of cases (511); light in 22.9% (179); moderate in 11% (86); and severe in 0.6% (5). Seven predictive variables were strongly related to postoperative pain: gender (female); age (younger than 33); number of extracted teeth (three); surgical technique (surgical flap, ostectomy, or teeth sectioning); number of local anesthetic cartridges (more than three); time in surgery (greater than 25 minutes); and any surgical complications. These variables were used to compose the PPI. The retained PPI classified 66.3% of the patients correctly for both pain and no pain; however, when more than three points were scored on the PPI, it correctly predicted pain in 55.6% of cases. **Conclusion:** The present study identified seven predictive variables that were strongly related to postextraction pain and documented that the PPI could correctly predict pain in the majority of patients.
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Tooth extraction is a common procedure in general dental clinics. Patients sometimes experience pain after tooth extraction, which can vary in the degree of severity. The International Association for the Study of Pain (IASP) defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage."[1] The definition emphasizes both the physical and emotional nature of pain, as pain is a multidimensional phenomenon with sensory, physiologic, cognitive, affective, behavioral, and spiritual components. Emotions (affective component), behavioral responses to pain, beliefs, attitudes, spiritual and cultural attitudes about pain, and pain control (cognitive component) all alter the way that pain is experienced by modifying the transmission of noxious stimuli in the brain.[1–4] Although the subject of pain has been extensively investigated in several fields, pain related to routine extraction has had limited study, and very few recently published manuscripts have focused on this postoperative complication.[2,3,5,6]

Al-Khateeb and Alnahar[2] evaluated the experience of pain after basic, uncomplicated tooth extraction and observed that 81.8% of patients (mostly female) had pain on the evening of extraction, and these authors recommended offering regular analgesic drugs during the first week after tooth extraction. Bortoluzzi et al[3] evaluated postoperative pain in 520 consecutive dental extractions for patients who had either a single tooth or multiple erupted teeth extracted. Their results showed that an increased pain level was associated with ostectomy, postoperative complications, and smoking. Pain that persisted for more than 2 days was associated with the amount of anesthetic solution used, notable increases in surgical time, and the development of postoperative complications. Tong et al[6] evaluated postextraction complications at a dental school and reported that dry socket and pain were major complications.

The aims of this observational, prospective, and exploratory clinical study were to identify relevant variables that may predict pain after routine extraction of erupted teeth, to construct a Pain Prediction Index (PPI) based on these variables, and to verify how these variables are related by using valid structural equation modeling (ie, path analysis). Greater knowledge about these pain-related variables may have major implications for oral health care by helping dental professionals to anticipate complaints about pain and aiding the implementation of clinical improvements in treatment planning, patient management, and prognosis. Such achievements may reinforce the commitment of patients to dental treatment.

Materials and Methods

This was an observational, prospective, and exploratory study for postoperative memory of pain after extraction of erupted teeth that included systematic data collected under similar conditions from March 2007 to December 2016. The data were obtained from two Brazilian universities (Oeste de Santa Catarina University [2007–2011] and Ponta Grossa State University [2012–2016]) and were supervised and scrutinized by a team of oral and maxillofacial surgeons on duty and under a single coordinator. The study protocol was submitted to the ethical boards at both universities and was approved as follows: UNOESC/HUST Ethical Committee for Human Research (approved under number 250/2005) and UEPG/COEP (approved under number 792.982). All the patients signed an informed consent form.

Dental Extractions

All of the dental extractions were performed by undergraduate dental students under similar conditions in the university dental surgery clinics. All of the procedures were performed using rigorous control of microbiologic contaminants, including use of a sterile surgical apron, sheets, and gloves. All the dental handpieces, drills, and surgical instruments were sterilized under an autoclave. Sterile saline solution was used for bur refrigeration whenever necessary and for washing and cleaning the surgical site. The final sample included data from 781 surgical procedures.

Data Collection

The questionnaire given was comprised of 60 questions directed at the patient and at the student who performed the surgical procedure and was completed before surgery, immediately after surgery, and at the end of the seventh postoperative day. The questionnaire included information concerning the following: demographic data; general health status; preoperative anxiety as rated on a VCS; tobacco and alcohol consumption habits; surgical site status; periodontal disease; suppuration at the site; extracted teeth; surgical technique used (eg, surgical flap, ostectomy, teeth sectioning); time spent in surgery; complications; preoperative and postoperative prescriptions; and outcome of surgery (postoperative complications and pain). Up to three teeth were considered for the procedures. The patients were re-assessed 7 days postoperatively (or before or after this period if necessary due to postoperative complications such as infection or dry socket). For patients who did not return on the seventh postoperative day, a phone call was made to collect information regarding the outcomes; the information about how many patients returned for the postoperative review and how many patients it was necessary to call is unavailable.

Pain Evaluation

Pain was self-reported and evaluated with a VCS on the seventh postoperative day with answers ranging from 0 to 3 (0 = none, 1 = light, 2 = moderate, and 3 = severe).[3,5,7] As indicated by Ong and Seymour,[7] the strengths of a VCS include the ease with which it can be administered and scored. Additionally, because it is generally easy to understand, a VCS is as good as or better than other measures of pain intensity under most conditions. Taking into consideration the overall postoperative period, the pain was further classified by the patients as qualitative or cognitive-evaluative pain dimension, which reflects the patient's evaluation of memory and meaning as well as the possible consequences of pain and injury.[3,5,7–9]

Analgesics were prescribed to all patients due to ethical reasons; however, the patients were instructed to take the medication only if necessary and as soon as the pain started (ie, the analgesics were patient controlled). Acetaminophen (500 mg) and dipyrone (500 mg) were the chosen analgesics and were used as preferred by the professional in charge.

Inclusion Criteria

The study participants were as follows: research patients who agreed to participate in the study and who signed an informed consent form; and patients with a clear extraction indication, such as advanced caries, periodontal disease, failure in endodontic treatment, tooth unrecoverability, prosthetics, or orthodontic indication.

General Exclusion Criteria

Patients were excluded for the following reasons: mental or psychiatric disability; pregnant; the extraction of impacted or partially impacted third molars and deciduous teeth; pediatric patients without legal representation; extractions under general anesthesia; extractions involving more than three teeth; and situations where it was impossible to contact the patient for a postoperative evaluation. As the data were evaluated, gross inconsistencies in the questionnaire answers and lack of relevant information were also criteria for exclusion.

Exclusion Criteria for Pain Evaluation

The exclusion criteria for pain evaluation included all the general exclusion criteria mentioned above and the following: aged 15 or under; acute preoperative pain and under the influence of analgesics, anti-inflammatory medicines, or antibiotics; anti-inflammatory or antibiotic medication prescribed postoperatively; and development of postoperative complications such as infection or dry socket.

Database

The database was gradually enlarged and verified for missing data and inconsistencies every 6 months. If it was not possible to contact patients or if they failed to attend their postoperative appointments, their data were not inserted into the database. The number of such losses was constant, at an approximate rate of 10% to 15% (164 losses). When all the inconsistencies and important missing data were cleared by excluding those individuals, the final database included 1,196 surgical extraction procedures. Whenever a patient needed more than one procedure (which was quite common) to finalize their surgical dental treatment, a new procedure was counted with a new outcome. When the exclusion criteria for pain evaluation (as described above) were applied, the final sample totaled 781 surgical procedures.

Statistical Analyses

The database was searched for predictive variables that were significantly associated with postoperative pain ($P < .05$). A tree-based analysis was applied to merge categories and to discretize the continuous variables, as well as to build a model to predict postoperative pain. In order to explore and analyze the data, pain was dichotomized into no pain (score of 0) and pain (score of 1 to 3). In an attempt to predict more relevant pain, it was also dichotomized into none to mild (score 0 to 1) and moderate to severe (score 2 to 3). Pain was also analyzed in its raw score (ordinal from 0 to 3). Several statistical methods and tests were then applied for data mining purposes, such as descriptive statistics, decision tree, chi-square test, Spearman correlation, binary logistic regression, and linear regression (IBM SPSS 15.0).

Pain Prediction Index

All of the retained predictive variables were scored at 0 or 1 based on their statistical influence for pain development and summed into a single index that might indicate predictability for postoperative pain. A valid model of structural equation modeling[8] (IBM SPSS Amos 24.0) was used to explain the retained variables, and the PPI could then be built to corroborate and explain the findings.

Results

The final sample contained 781 patients who had undergone a tooth extraction procedure. A total of 55.2% of these patients (431) were male, and the mean age for all patients ranged from 16 to 85 years (mean 42.8, standard deviation [SD] 14.6). Systemic disease was detected or informed in 19.7% (154) of the patients; however, the use of daily medicine was reported by 35.7% (these numbers may have included contraceptives, herbal medicines, and vitamins). A total of 22.5% of patients were smokers, while weekly alcohol consumption was reported by 18.4%. Hypertension was the most commonly identified disease (12.4% of patients). On the day of the procedure, 15 female patients reported that they were menstruating. The majority of the sample (76.2%) had a single tooth extraction, followed by two teeth (18.6%) and three teeth (5.2%). Due to a possible mixture of extracted teeth, the areas of surgery were classified as follows: including only incisor teeth (11.4%); including at least one canine (8.5%); including at least one premolar (26%); and including at least one molar (54.2%). The mean time of the procedure was 41 minutes to finish the dental extraction, including the suture. Of the procedures performed, 22.1% were surgical flap, 6.9% were ostectomies, and 9.2% were tooth sectioning.

Ordinal Pain Evaluation

Pain was scored by patients as 0 in 65.4% of cases; 1 in 22.9%; 2 in 11%; and 3 in 0.6% . Nonparametric Spearman correlation showed weak but statistically significant correlations between pain and surgical time ($P = .04$), anxiety ($P = .01$), amount of anesthetic ($P = .03$), and age (negative, $P = .02$). To discretize both the linear and ordinal predictive variables for further analysis, a decision tree (chi-square automatic interaction detection [CHAID] method) was applied, categorizing pain as dichotomous (yes/no). It was observed that patients younger than 33 reported a higher percentage of pain (42.0%; $P = .026$) than patients

Table 1 Bivariate Chi-Square Analysis of Pain Variables Reported as Dichotomous, None to Light, and Moderate to Severe (n = 781)

	Pain			Pain		
Variable (n)	No	Yes	χ^2	None to light	Moderate to severe	χ^2
Gender						
Female	210	140	$P = .004$	391	40	$P = .022$
Male	301	130		299	51	
Age						
< 33 y	140	102	$P = .003$	208	34	NS
≥ 34 y	371	178		482	57	
Anxiety						
None to light	285	125	$P = .012$	372	38	$P = .029$
Moderate to severe	226	145		318	53	
Systemic disease						
Yes	98	56	NS	135	19	NS
No	413	214		555	72	
Daily medicines						
Yes	173	106	NS	244	35	NS
No	338	164		446	56	
Contraceptives						
Yes	69	41	NS	95	15	NS
NA/no	442	229		595	76	
Smoker						
Yes	108	68	NS	153	23	NS
No	403	202		537	68	
Weekly alcohol						
Yes	102	42	NS	133	11	NS
No	409	228		557	80	
Surgical area						
Only incisors	61	28		79	10	
At least one canine	43	23	NS	56	10	NS
At least one premolar	135	68		185	18	
At least one molar	272	151		370	53	
No. of teeth extracted						
1	396	199		531	64	
2	95	50	NS	129	16	$P = .008$
3	20	21	$P = .021$	30	11	$P = .002$
Surgical flap						
Yes	102	76	$P = .009$	149	29	$P = .028$
No	409	194		541	62	
Ostectomy						
Yes	27	27	$P = .013$	40	14	$P = .001$
No	484	243		650	77	
Tooth sectioning						
Yes	39	33	$P = .035$	56	16	$P = .003$
No	472	237		635	75	
No. of local anesthetic cartridges						
< 3 tubes	485	239	$P = .001$	642	82	NS
≥ 3 tubes	28	31		48	9	
Surgical complications						
Yes	23	24	$P = .014$	37	10	$P = .034$
No	488	246		653	81	
Surgical time						
< 25 min	170	66	$P = .011$	223	13	$P < .001$
≥ 25 min	341	204		467	78	
Suppuration at the site						
Yes	21	13	NS	32	2	NS
No	490	257		658	89	

NS = not significant; NA = not applicable.

who were older than 33 (31.2%) and that procedures lasting longer than 25 minutes resulted in a higher percentage of reported pain (37.4%; $P = .004$) than procedures lasting less than 25 minutes (28%). It was also observed that procedures that used more than three cartridges of local anesthetic resulted in a higher percentage of reported pain (54.4%; $P = .001$) than procedures using fewer than three cartridges (33%).

Table 2 Logistic Regression Analysis of Pain Variables Reported as Dichotomous and None, Light to Moderate, and Severe (n = 781)

	Pain (yes/no) Logistic regression (*P* value)		Pain (none, light/moderate, severe) Logistic regression (*P* value)	
Variable	Standard	Forward LR	Standard	Forward LR
Gender	.009	.008	NS	.014
Age	.002	.018	NS	NS
Anxiety	NS	NS	NS	NS
Systemic disease	NS	NS	NS	NS
Daily medicines	NS	NS	NS	NS
Contraceptives	.04	NS	NS	NS
Smoker	.044	NS	NS	NS
Weekly alcohol	NS	NS	NS	NS
Surgical area	NS	NS	NS	NS
Number of teeth extracted	.015	.012	.004	.002
Surgical flap	NS	.038	NS	NS
Ostectomy	NS	NS	NS	.013
Tooth sectioning	NS	NS	.019	.020
No. of local anesthetic cartridges	.024	.005	NS	NS
Surgical complications	NS	.037	NS	NS
Surgical time	NS	NS	.003	.001
Suppuration at the site	NS	NS	NS	NS

NS = not significant; LR = forward likelihood.

In terms of anxiety, it was noted that patients who reported moderate to severe anxiety levels reported a higher percentage of pain (39.1%; $P = .01$) than those reporting low or no anxiety (30.5%).

Dichotomous and VCS Pain

The analyses for pain as dichotomous and as none, light, moderate, or severe were performed with chi-square tests. The results concerning the chi-square bivariate analysis are summarized in Table 1, which shows that the number of teeth removed was recoded into one to two teeth and three teeth, indicating that the pain reported was significantly higher for patients who had three teeth removed compared to those who had one to two teeth removed.

All 17 variables used in the bivariate analysis were included in a logistic regression analysis using two methods: a standard method, which kept all the variables in the final model, and a forward likelihood (LR) method, which retained the most relevant variables for reporting pain. The analysis was repeated searching for variables that were important for moderate to severe pain, and the results of this analysis are shown in Table 2. The interactions between the variables in the binary logistic regression may have suppressed some relevant factors that were observed in the chi-square analysis, such as anxiety or the performance of flap surgery or ostectomy. The variables were ranked according to their importance by number of appearances in Tables 1 and 2 as follows: *(1)* number of teeth extracted (appeared/scored six times); *(2)* gender (appeared/scored five times); *(3)* surgical time and tooth sectioning (appeared/scored four times each); *(4)* age, surgical complications, surgical flap, number of local anesthetic cartridges, and ostectomy (appeared/scored three times each); *(5)* anxiety (appeared/scored twice); and *(6)* tobacco and contraceptives (appeared/scored once each).

Since surgical flap, ostectomy, and tooth sectioning were relevant in the bivariate analysis (chi-square) and surgical flap was relevant in the logistic regression for dichotomous pain (although it was not relevant for severe/moderate pain, and the exact opposite was true for ostectomy and tooth sectioning), the authors decided to merge those three related variables into a single variable called surgical technique, which took into account a positive score whenever it was performed. Thus, categorizing a surgical technique as "yes" meant that at least one of the three techniques was used (surgical flap, or ostectomy, or teeth sectioning). After re-running all the statistical tests, surgical technique was kept as highly significant in the six analyses (appeared/scored six times).

Pain Prediction Index

The aim of creating a PPI was to provide an index that could better explain the highest proportion of pain response in the sample. The first index that was created included all 12 predictive variables that showed any statistical significance. All the variables were scored

Table 3 Linear Regression, Spearman Correlation, and Decision Tree for Different Versions of Pain Prediction Index (PPI) Based on Scores Related to Pain Scores (0–3), Presence of Pain (Decision Tree), and Moderate/Severe Pain (Decision Tree) (n = 781)

PPI variables included	Version/no. of variables	Linear regression (version *X* pain [0–3])	Spearman correlation (version *X* pain [0–3])	Decision tree	
				Pain: Yes (%)	Pain: Moderate/ severe (%)
Gender; age; anxiety; tobacco; contraceptives; no. of teeth extracted; surgical flap; ostectomy tooth sectioning; no. of local anesthetic cartridges; surgical time; surgical complications	V1/12, scored 0–12	$\beta = 0.11$; $P < .001$	$\rho = 0.23$; $P < .001$	Scores > 4; 53.8	Scores > 3; 19.5
Gender; age; anxiety; tobacco; contraceptives; no. of teeth extracted; surgical technique; no. of local anesthetic cartridges; surgical time; surgical complications	V2/10, scored 0–10	$\beta = 0.12$; $P < .001$	$\rho = 0.23$; $P < .001$	Scores > 4; 55.9	Scores > 3; 20
Gender; age; anxiety; no. of teeth extracted; surgical technique; no. of local anesthetic cartridges; surgical time; surgical complications	V3/8, scored 0–8	$\beta = 0.14$; $P < .001$	$\rho = 0.24$; $P < .001$	Scores > 3; 51.9	Scores > 3; 21.9
Gender; age; no. of teeth extracted; surgical technique; no. of local anesthetic cartridges; surgical time; surgical complications	V4/7, scored 0–7 (selected)	$\beta = 0.15$; $P < .001$	$\rho = 0.23$; $P < .001$	Scores > 3; 55.6	Scores > 3; 25.4
Only surgery-related variables: No. of teeth extracted; surgical technique; no. of local anesthetic cartridges; surgical time; surgical complications	V5/5, scored 0–5	$\beta = 0.17$; $P < .001$	$\rho = 0.2$; $P < .001$	Scores > 1; 45.3	Scores > 1; 18.6
Variables with an importance score > 4: Gender; no. of teeth extracted; surgical technique; surgical time	V6/4, scored 0–4	$\beta = 0.18$; $P < .001$	$\rho = 0.2$; $P < .001$	Scores > 1; 42	Scores > 1; 18.1

0 or 1 depending on their impact on pain; for example, female patients reported a greater percentage of pain compared to male patients, so females scored 1 for gender, and patients younger than 33 reported a greater percentage of pain, so those younger patients scored 1 for age. The criteria for trimming off variables from the PPI was based on the improvement of statistics and the importance of variable scores.

Although all versions of the PPI (Table 3) explained response to pain to a certain degree, the most balanced version (with the best sample-explaining percentage and with the lowest number of variables) was version 4, which contained the following predictive variables: gender (female); age (younger than 33); number of extracted teeth (three); surgical technique (surgical flap, ostectomy, or teeth sectioning); number of local anesthetic cartridges (more than three); surgical time (greater than 25 minutes); and any surgical complications. The statistical analysis using the CHAID method indicated that the PPI correctly classified 66.3% of the patients for determining pain and no pain; however, when more than three points were scored, it correctly predicted pain in 55.6% of cases. When the score on the PPI was four or more points, it showed the following parameters for pain prognosis (yes/no): specificity 94.5% (95% confidence interval [CI] 92.18% to 96.33%); sensitivity 13% (95% CI 9.20% to 17.56%); positive predictive value 55.6% (95% CI 43.75% to 66.77%); and negative predictive value 67.2% (95% CI 66.15% to 68.37%).

Path Analysis

A path model was created to examine the interactions of the variables and effects over the retained PPI and its effect over pain. A path model is a structural model for observed variables and represents the hypothesis of correlated causes. Figure 1 depicts the relationship between the predictive variables retained in the final version of the PPI and pain through a recursive model, which contains unstandardized estimates obtained through a maximum likelihood method, including all 781 surgical procedures. The fit statistics for the described model were as follows: chi-square $P = .24$; Jöreskog–Sörbom goodness of fit index (GFI) 0.99; Bentler comparative fit index (CFI) 0.99; the adjusted goodness of fit index (AGFI) 0.98; the Tucker-Lewis coefficient (TLI) 0.99; the root mean square residual (RMR) 0.01; and the Steiger-Lind root mean square error of approximation (RMSEA) 0.01. All of the indexes and parameters indicated an excellent adjusted model. All of the estimates or paths in the model were statistically significant at $P < .001$, except for surgical technique to age ($P = .001$) and the number of local anesthetic cartridges to age ($P = .03$). All nonsignificant paths were removed from the final model. It was found that the estimate for the PPI for pain (0.15) was exactly the same (β) as the linear regression, which is shown in Table 3. Since the model was built to explain the interaction of the variables in order to explain PPI and PPI was devised to explain pain, no direct paths from the variables to pain were included in the model; however, the indirect effect (unstandardized) for each variable over pain was obtained as follows: gender (0.17); age (–0.04); number of extracted teeth (0.15); surgical technique (0.2); number of local anesthetic cartridges (0.17); surgical time (0.16); and any surgical complication (0.22).

Discussion

Pain is a very complex phenomenon because it can be influenced by several factors, such as psychological profile, genetics, age, gender, and inflammatory processes related to disease or tissue damage. Further factors that should be taken into consideration include modulators such as habits, previous pain experiences, and many other variables.[2–5,10–12] Pain can often be puzzling for dental professionals because every patient has a particular behavior when pain is present and because similar procedures can trigger different pain responses. Surprisingly, despite the fact that it is quite common in dentistry, pain related to routine extractions has had limited study except in the case of third molar surgeries.[2,3,5]

According to Kyle et al,[4] reports of pain and anxiety are significantly related to their respective memories, but pain and anxiety associated with tooth extraction also appear to blend together in memory over time. Interestingly, the pain that is recalled may be related to the state of anxiety during the extraction. Consequently, patients' memories of pain are extremely clinically relevant because it is their perceptions of dental treatment that linger and that will be remembered at the time of the next dental treatment. The results of the present study have demonstrated that anxiety is related to the memory of pain, as also observed by Kyle et al[4]; however, there is no direct path between the two. An indirect or intrinsic value may be assumed when the variables are put together, as observed in the logistic regression and in a near equivalent path analysis, which are not included in the results of this study. The path analysis showed that anxiety may modulate gender and age. Kyle et al[4] also observed that, similar to what was found in the present study, procedure duration and number of teeth extracted were also associated with recalled pain and may predict it.

The memory of pain was also chosen by Deschaumes et al[12] to explore pain predictors after tooth extraction. The aforementioned authors found that high resting blood pressure was related to lower oral postsurgical pain, suggesting that it may be a protective factor. The present study evaluated blood pressure, which was classified as low, ideal, and high; however, these data were not included in the analysis because they did not show any significant, or even nearly significant, influence on postoperative pain. The findings of Deschaumes et al[12] may have been due to the method of blood pressure analysis (numeric scalar) and confounding factors.

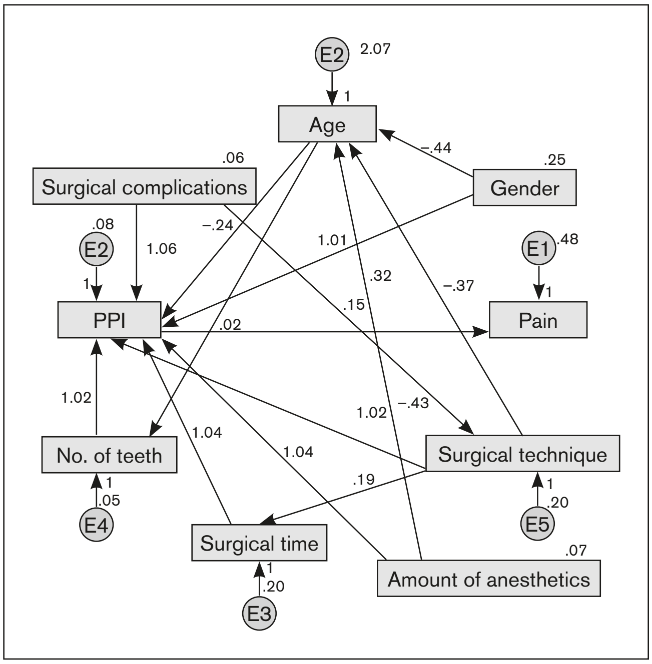

Fig 1 Unstandardized estimates of a recursive structural equation model (maximum likelihood method) showing the relationship between the predictive variables retained for pain in the final version of the Pain Prediction Index (n = 781). E = proportion of unexplained variance. Each number indicates that the variance applies only to that variable.

Rudin et al[10] evaluated some predictors for postoperative pain after third molar surgery. After analyzing different perceptions of pain at 14 postoperative days, they observed that psychological vulnerability (the sum of reported postoperative pain from 0 to 14 days) and heat pain threshold (the maximum reported postoperative pain from 0 to 14 days) may be predictors of pain. After excluding the postoperative complications from their 38 procedures, anxiety was also shown to be predictive for pain in a subgroup analysis, while heat pain perception was a significant predictor for maximum reported pain during drinking. Notably, no surgical aspects, except for the duration of surgery, were included in the analysis[10]; furthermore, age and gender were also not considered relevant for predicting pain. Obviously, the results obtained by Rudin et al[10] and the results of this present study cannot be directly compared due to important differences in both research protocols; however, the data obtained in the present study imply that being female and younger may be predictors for pain related to dental extraction. Al-Khateeb and Alnahar[2] also found that female patients experienced pain significantly more than male patients after simple uncomplicated tooth extraction. The implications as to why the variables of gender and age were interconnected in the path model analysis were not clear. Perhaps previous pain experiences for young patients may be a modulator, as well as dental anxiety for female patients.[13]

As there is scant information concerning pain after routine extraction of erupted teeth, the findings of the present study should be compared to those of third molar surgeries and the differences between those surgeries made clear. In a review manuscript, Rakhshan[11] searched for risk factors for postoperative pain after third molar surgery and reported the following: poor oral hygiene (few studies); the difficulty of extraction (including the length of surgery or trauma); the surgeon's expertise; tobacco smoking, being female (most of the reviewed studies); the use of contraceptives (unlikely); and age. Age as a risk factor is controversial because some studies have shown greater pain for older patients, while other studies show the contrary. Rakhshan[11] has stated that there are obstacles in relation to detecting possible links between pain and risk factors, such as the consumption of painkillers and antibiotics, poorer statistical approaches, and the confusion of whether pain is caused by a dry socket or infection. In the present study, all the cases in which anti-inflammatory medications and antibiotics were used, both before and/or after the procedure, were excluded from the sample, as well as the cases of dry socket and infection. The different analyses used here—such as bivariate, standard logistical regression, and a stepwise method to remove less relevant variables—clearly showed that some variables may be controlled or modulated by or interact with other variables. The path model was used in an attempt to explain the PPI, how the PPI can explain pain, and to use the indirect effect to explain how each predictor also explains pain. For example, the model explains that the retained risk variable of the number of local anesthetic cartridges used is negatively related to age and positively related to PPI and pain. This means that a higher level of local anesthesia was required by young patients; the higher the level, the greater the pain, and the higher the PPI score. The difficulty of the surgery, which may be highly subjective when scored by a dentist with little or much experience, can be directly scored considering surgical technique and time spent in surgery, but interestingly, surgical technique is influenced by surgical complications and exerts its influence on age (negative) and surgical time. These are examples of variables interfering with each other. The involvement of dental students to carry out the extractions might be considered a study limitation, since they would have less experience with this surgery than general dental practitioners, but this may not limit the study's documented utility of the PPI for predicting pain after minor oral surgery.

Although the findings of the present study are interesting and relevant, they nonetheless should be viewed with caution because the PPI may incorrectly predict around 33% of patients and it may also not explain 48% of the pain variance obtained in the path analysis. This indicates that there are possibly many other variables that were not captured by this study, such as psychological profile, the modulation of consumed analgesics, the individual pain threshold and the factors that modulate it, and the method used. One important limitation in constructing the PPI was based on the concept that postoperative pain is basically pain of inflammatory origin, disregarding the psychological traits of patients as observed by others.[4,10,13] Thus, a more complex and robust index should be constructed in future research. Nevertheless, establishing a psychological profile or traits before any dental extraction is a difficult task and impractical for quick and easy clinical use, and therefore may be restricted to academic activity, at least for now.

Conclusions

The results of this study suggest that seven predictive variables were strongly related to postoperative pain after routine erupted dental extractions. These were gender (female); age (patients younger than 33); the number of extracted teeth (three); surgical technique (surgical flap, ostectomy, or teeth sectioning); the number of local anesthetic cartridges (more than three) used; the time in surgery (greater than 25 minutes); and any surgical complications. These variables were used to compose the PPI, which was shown to be an easy tool, directly scored from 0 to 7 and based only on practical, clinically available yes or no answers. The PPI correctly classified 66.3% of the patients for both pain and no pain. However, when more than three points were scored on the PPI, it correctly predicted pain in 55.6% of the cases, allowing clinicians to anticipate pain response and to improve pain control prescriptions, which in turn may provide dental surgery patients with a more comfortable postoperative experience.

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