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Extraction of mandibular third molars: relationship of preoperative anxiety with body mass index, serum high-sensitivity C-reactive protein levels, and visual analog scale scores and predictors of postoperative complications

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Abstract (J Korean Assoc Oral Maxillofac Surg 2023;49:252-261)

Objectives: Patients undergoing oral surgery exhibit high anxiety, which may elevate their cortisol levels and affect postoperative recovery. Overweight patients are often encountered in the dental clinic due to the increasing prevalence of overweight. We aimed to investigate the relationships between preoperatively assessed body mass index (BMI), serum cortisol and high-sensitivity C-reactive protein (hs-CRP) levels, and visual analog scale (VAS) scores and preoperative anxiety in patients undergoing mandibular third molar (MM3) extraction and to identify predictors of postoperative complications.

Patients and Methods: We analyzed 43 patients (age, 20-42 years) undergoing MM3 extraction. At the first visit, patients completed the Modified Dental Anxiety Scale (MDAS) and Amsterdam Preoperative Anxiety and Information Scale (APAIS) questionnaires. Their BMI and VAS scores were also calculated. The participants underwent blood tests 1 hour before MM3 extraction. On the first postoperative day, the participants' VAS scores and serum hs-CRP levels were reevaluated.

Results: We found that BMI was significantly correlated with preoperative VAS scores. Further, BMI and preoperative hs-CRP levels were significantly correlated among women and patients undergoing extractions of fully impacted MM3s. No correlations were found between serum cortisol and other variables. The preoperative MDAS and VAS scores were significantly positively correlated, especially among patients undergoing extractions of fully impacted MM3s. Multiple linear regression showed that BMI and the eruption status of the MM3 were significant predictors of postoperative hs-CRP levels and VAS scores, respectively.

Conclusion: In MM3 removals, patients with higher BMI showed elevated hs-CRP and higher VAS scores before surgery. Patients with higher anxiety among those undergoing extractions of fully impacted MM3s showed higher preoperative VAS scores. The two main predictors of postoperative complications were BMI and MM3 eruption status.

Key words: Dental anxiety, Body mass index, High-sensitivity C-reactive protein, Postoperative recovery

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I. Introduction

Clinicians commonly encounter patients with fear and anxiety related to dental treatment. Dental treatment has been described as the fifth-most common cause of anxiety[1], and dental phobia has been ranked the fourth-most common phobia[2]. Dental anxiety may be triggered by injections of anesthesia, use of rotary instruments, or tooth extraction[3]. Patients undergoing extraction of the mandibular third molar, which requires anesthesia and osteotomy, may experience severe dental anxiety. According to Kazancioglu et al.[4], patients undergoing oral and maxillofacial surgery show higher levels of anxiety than those undergoing any other type of medical sur-

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gery. Dental anxiety serves as a critical obstacle for dentists attempting to provide appropriate treatment and may also delay postoperative healing. Preoperative anxiety in patients undergoing mandibular third molar extraction may affect the intensity of postoperative pain[5,6] and occurrence of postoperative complications, such as inflammation and trismus[7,8]. Gao et al.[9] found that postoperative complications were significantly lower in patients with mild anxiety than in those with severe anxiety.

Litt[10] reviewed the relationship between anxiety and pain perception and found that anxiety lowers the pain threshold and causes painless stimuli to be considered painful. Anxious and painful situations during dental treatment might be stressors to patients. Stressors can induce activation of the hypothalamic-pituitary-adrenal axis, which elevates cortisol levels. Cortisol is a "stress hormone" secreted by the adrenal glands and can be detected in serum, urine, and saliva. The levels of cortisol and dental anxiety are reportedly associated with each other[11-13]. Benjamins et al.[11] showed that salivary cortisol concentrations were significantly elevated in patients exhibiting anxiety.

The prevalence of overweight is increasing, and dentists commonly encounter overweight patients in their practices. Previous studies have shown a positive correlation between obesity and anxiety disorders or specific phobias[14-16]. Preiss et al.[14] found that anxiety was highly associated with obesity. Depression and anxiety disorders have been observed in patients with obesity undergoing surgical treatments[15]. Tayefi et al.[16] found that patients with higher anxiety levels had elevated serum high-sensitivity C-reactive protein (hs-CRP) levels and higher body mass index (BMI).

The purpose of this study was to investigate whether BMI, serum cortisol and hs-CRP levels, and preoperative visual analog scale (VAS) scores for pain are associated with preoperative dental anxiety in patients undergoing mandibular third molar extractions and to identify predictors of postoperative complications.

II. Patients and Methods

1. Patients

Patients undergoing surgical extraction of a mandibular third molar at the Department of Oral and Maxillofacial Surgery of Kyung Hee University Hospital at Gangdong, Seoul, Korea, between December 2022 and March 2023, were screened for inclusion. The study design was explained to all patients, and written consent for participation was obtained. The study design was approved by the Institutional Review Board of Kyung Hee University Hospital at Gangdong (approval No. KHNMC 2022-08-031-004). This study was performed in accordance with the guidelines and regulations of the Declaration of Helsinki.

• Inclusion criteria: We included patients whose ages were between 20 and 50 years, who had no history of systemic diseases, and no regular use of medication. The included patients were able to complete all questionnaires without assistance.

• Exclusion criteria: Patients who had local infections or pus discharge at the mandibular third molar were excluded from this study. Patients with any infectious disease and who were pregnant were also excluded, as were patients who were unable to complete all questionnaires without assistance.

2. Preoperative assessment of anxiety and pain

All participants were asked to complete Korean versions of two questionnaires, the Modified Dental Anxiety Scale (MDAS) and Amsterdam Preoperative Anxiety and Information Scale (APAIS), by themselves at the first visit. In addition, they were asked to rate the intensity of their pain due to the mandibular third molar on a 10-cm VAS.

1) MDAS

The MDAS is a modification of the Corah's Dental Anxiety Scale. It is widely used to assess the severity of dental anxiety in patients. The MDAS consists of two factors, expected dental anxiety and therapeutic dental anxiety, and comprises five questions. Each question includes five items, and the responses range from 1 (not anxious) to 5 (extremely anxious)[17]. The total score ranges from 5 to 25. An MDAS score of ≥12 indicates dental anxiety and that of ≥19 indicates a high degree of dental anxiety, that is, dental phobia.

2) APAIS

The APAIS was developed to assess patients' preoperative anxiety[18]. The APAIS consists of six items, four of which are related to dental anxiety (two items are related to surgery and two to anesthesia). The other two items assess the need for information about the procedure and anesthesia. The scale scores range from 1 (not at all) to 5 (extremely), and the overall score can range from 6 to 30. Patients with a score of 11 are considered to be anxious. Various research groups have proven the validity of the APAIS[19].

3) VAS

A VAS was used to assess patients' severity of pain. It consists of a 10-cm line with 0 (no pain) at one end and 10 (worst possible pain) at the other.

3. Preoperative assessment of BMI

The participants' body weights and heights were measured at the first visit to our outpatient department. BMI was calculated as body weight/height^2 (kg/m^2).

4. Blood tests

Blood samples of 8 mL were obtained from all participants 1 hour preoperatively. Tests for the following were performed:

(1) Complete blood count
(2) Erythrocyte sedimentation rate
(3) Prothrombin time and activated partial thromboplastin time
(4) CRP level
(5) hs-CRP level
(6) Hemoglobin A1c level
(7) Hepatitis B virus surface antigen
(8) Hepatitis C antibody
(9) Human immunodeficiency virus antibody
(10) Serum cortisol level
(11) Rapid plasma reagin test

5. Postoperative assessment of pain and inflammation

The patients were recalled on the first postoperative day for dressing of the surgical site. They underwent a second blood test for postoperative hs-CRP levels 1 hour before the appointment and were asked to rate the intensity of their postoperative pain on the VAS after placing the dressing.

6. Surgical procedure

All procedures were performed by one second-year resident student and one professor at the Department of Oral and Maxillofacial Surgery.

1) Initial visit

At the initial consultation visit, we performed oral examinations of all patients and obtained panoramic-view radiographs and cone-beam computed tomography images. Patients were routinely provided information regarding the extraction procedure, postoperative precautions, and possible complications of mandibular third molar extraction. They signed consent forms indicating their agreement to undergo extraction of the mandibular third molar after having received a thorough explanation of the procedure. All participants completed the MDAS, APAIS questionnaires, and VAS. The patients' body weights and heights were measured to calculate BMI.

2) Day of surgery

Patients visited the clinic 1 hour before the scheduled extraction to undergo blood tests. All extractions were performed under inferior alveolar nerve, lingual nerve, and buccal nerve blocks with two 1.8-mL capsules of 2% lidocaine with 1:100,000 epinephrine (Huons Co., Ltd.). A full-thickness mucoperiosteal flap was raised, generally after placing an incision distal to the lower second molar and along the length of the anterior border of the ascending ramus of the mandible. Osteotomy, coronal sectioning, or root sectioning was performed as required. The wound was closed with 3/0 black silk sutures (29 mm 1/2 Round; AILEE Co., Ltd.), and a piece of folded gauze was applied to aid hemostasis.

After surgery, we prescribed intramuscular injections of diclofenac to all patients to relieve pain. All patients received an antibiotic (cephalexin 1,000 mg/8 hours for 5 days), anti-inflammatory/analgesic agent (etodolac 200 mg/8 hours for 5 days), and antiseptic mouth wash (chlorhexidine 0.12%, mouth rinses daily for 7 days). The patients were also provided appropriate instructions and recommendations regarding the postoperative recovery period. We recalled the patients on the next day for follow-up.

Table 1. Variables studied for all patients

Variable	Mean±SD
Age (yr)	26.00±6.22
BMI (kg/m^2)	23.06±4.00
Preoperative MDAS score	12.05±3.56
Preoperative APAIS score	17.74±4.66
Preoperative VAS score	2.30±2.76
Preoperative hs-CRP level (mg/L)	1.01±1.42
Preoperative serum cortisol (μg/dL)	9.21±3.25
Postoperative hs-CRP (mg/L)	7.52±6.31
Postoperative VAS score	5.16±2.84

(SD: standard deviation, BMI: body mass index, MDAS: Modified Dental Anxiety Scale, APAIS: Amsterdam Preoperative Anxiety and Information Scale, VAS: visual analog scale, hs-CRP: high-sensitivity C-reactive protein)

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3) One day postoperatively

We recalled the patients on the next day for follow-up and dressing of the surgical site. One hour prior to the appointment, all patients underwent a second blood test to assess postoperative hs-CRP levels. A dressing was placed at the surgical site, and the participants completed the VAS for postoperative pain. The sutures were removed after 1 week.

7. Statistical analysis

Two multiple regression analyses were conducted with postoperative hs-CRP and VAS as dependent variables and

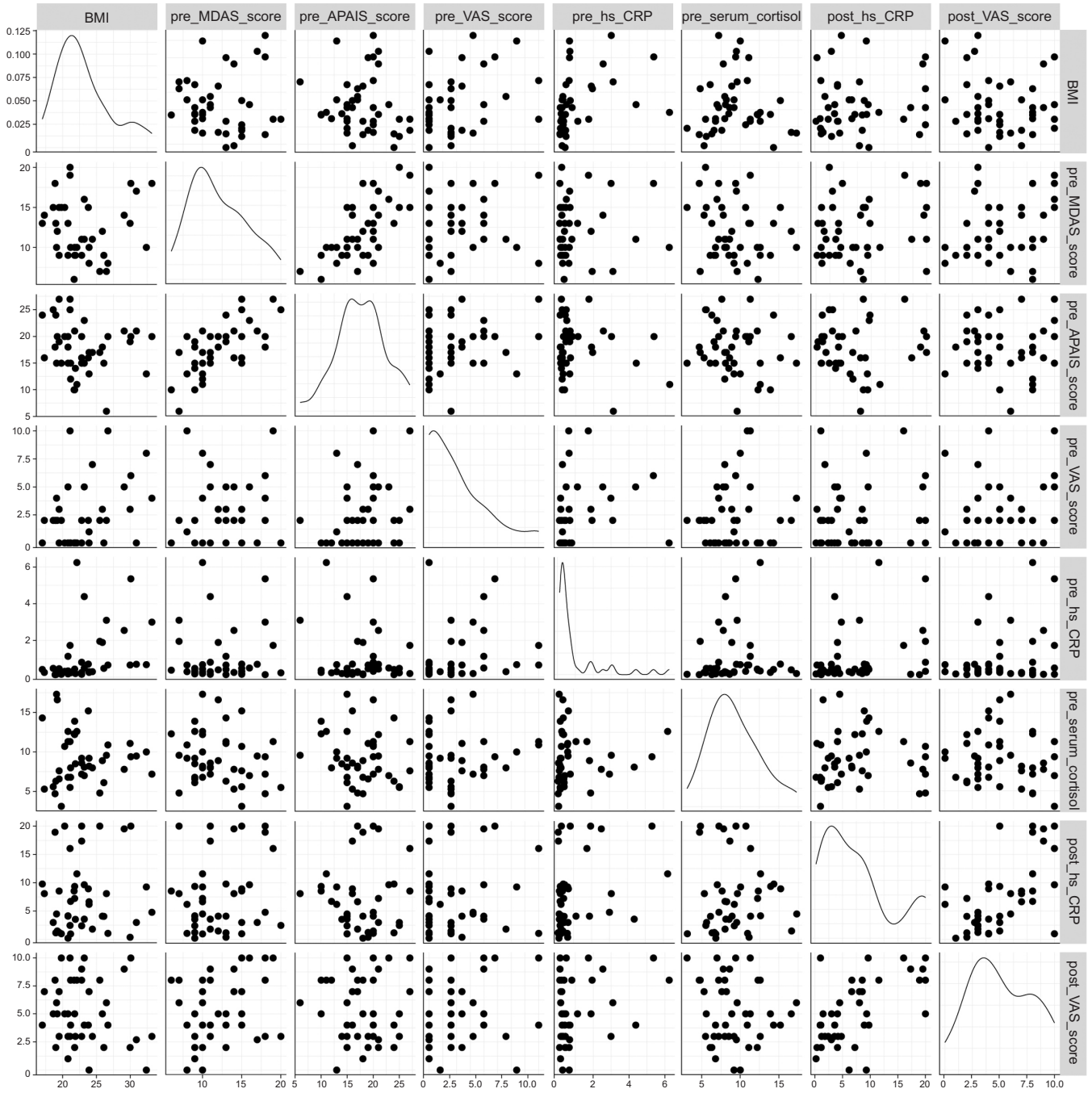

Fig. 1. Scatterplot for all measured variables. (BMI: body mass index, pre-MDAS: preoperative Modified Dental Anxiety Scale, pre-APAIS: preoperative Amsterdam Preoperative Anxiety and Information Scale, pre-VAS: preoperative visual analog scale, pre-hs-CRP: preoperative high-sensitivity C-reactive protein, pre-serum cortisol: preoperative serum cortisol, post-hs-CRP: postoperative high-sensitivity C-reactive protein, post-VAS: postoperative visual analog scale)

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other variables as independent variables. Pearson's correlation and *t*-tests were performed to examine the independence of independent variables. In addition, statistically significant correlations between all measured variables were investigated using Pearson's correlation *t*-test. Analyses were performed using R version 4.3.0 (The R Foundation; 2023). Statistical significance was set at $P<0.05$.

III. Results

Fifty patients were initially enrolled in this study. Two patients did not attend the surgical appointment and three refused to undergo a second blood test for postoperative hs-CRP levels. Two patients did not meet the inclusion criteria based on preoperative blood test findings: one patient tested positive for syphilis and another for hepatitis B. Finally, 43 patients were included. The effective rate was 83%. For a sample size is 43, a one-sided test, a significance level of 0.05, and a correlation coefficient of 0.36, the power of the test was 0.7784, indicating that a sample size of 43 observations is sufficient to detect a correlation coefficient greater than 0.36. This power analysis was performed using the pwr. Test function from pwr library in program R version 4.3.0.

The study sample comprised 18 females (41.9%) and 25 males (58.1%), and their mean age was 26 years (range, 20-42 years). Twenty-three participants (53.5%) underwent extraction of partially impacted mandibular third molars, and 20 participants (46.5%) underwent extraction of fully impacted mandibular third molars.

Table 1 summarizes the clinical characteristics of the participants. Fig. 1 presents the correlations of each studied

Table 2. Pearson's correlation coefficients between variables and results of *t*-tests

Variable 1	Variable 2	Pearson's correlation coefficient	*t*-value	*P*-value
BMI	Post-VAS score	–0.16	–1.06	0.30
BMI	Post-hs-CRP	0.09	0.59	0.56
BMI	Pre-APAIS score	–0.14	–0.89	0.38
BMI	Pre-MDAS score	0.04	0.28	0.78
BMI	Pre-VAS score	0.36	2.50	0.02*
BMI	Pre-hs-CRP	0.40	2.82	0.01*
BMI	Pre-serum cortisol	–0.04	–0.25	0.81
Post-hs-CRP	Post-VAS score	0.61	4.90	0.00**
Pre-APAIS score	Post-VAS score	0.06	0.37	0.72
Pre-APAIS score	Post-hs-CRP	0.06	0.41	0.69
Pre-APAIS score	Pre-VAS score	0.26	1.72	0.09
Pre-APAIS score	Pre-hs-CRP	–0.15	–0.96	0.34
Pre-APAIS score	Pre-serum cortisol	–0.16	–1.01	0.32
Pre-MDAS score	Post-VAS score	0.27	1.77	0.08
Pre-MDAS score	Post-hs-CRP	0.21	1.36	0.18
Pre-MDAS score	Pre-APAIS score	0.67	5.80	0.00**
Pre-MDAS score	Pre-VAS score	0.25	1.64	0.11
Pre-MDAS score	Pre-hs-CRP	0.10	0.67	0.51
Pre-MDAS score	Pre-serum cortisol	–0.20	–1.29	0.21
Pre-VAS score	Post-VAS score	0.14	0.87	0.39
Pre-VAS score	Post-hs-CRP	0.06	0.41	0.69
Pre-VAS score	Pre-hs-CRP	0.26	1.71	0.09
Pre-VAS score	Pre-serum cortisol	0.07	0.42	0.68
Pre-hs-CRP	Post-VAS score	0.28	1.90	0.06
Pre-hs-CRP	Post-hs-CRP	0.31	2.07	0.04*
Pre-hs-CRP	Pre-serum cortisol	0.06	0.38	0.71
Pre-serum cortisol	Post-VAS score	–0.12	–0.78	0.44
Pre-serum cortisol	Post-hs-CRP	–0.02	–0.11	0.91

(BMI: body mass index, Post-hs-CRP: postoperative high-sensitivity C-reactive protein, Pre-APAIS: preoperative Amsterdam Preoperative Anxiety and Information Scale, Pre-MDAS: preoperative Modified Dental Anxiety Scale, Pre-VAS: preoperative visual analog scale, Pre-hs-CRP: preoperative high-sensitivity C-reactive protein, Pre-serum cortisol: preoperative serum cortisol, Post-VAS: postoperative visual analog scale)

*$P<0.05$, **$P<0.01$.

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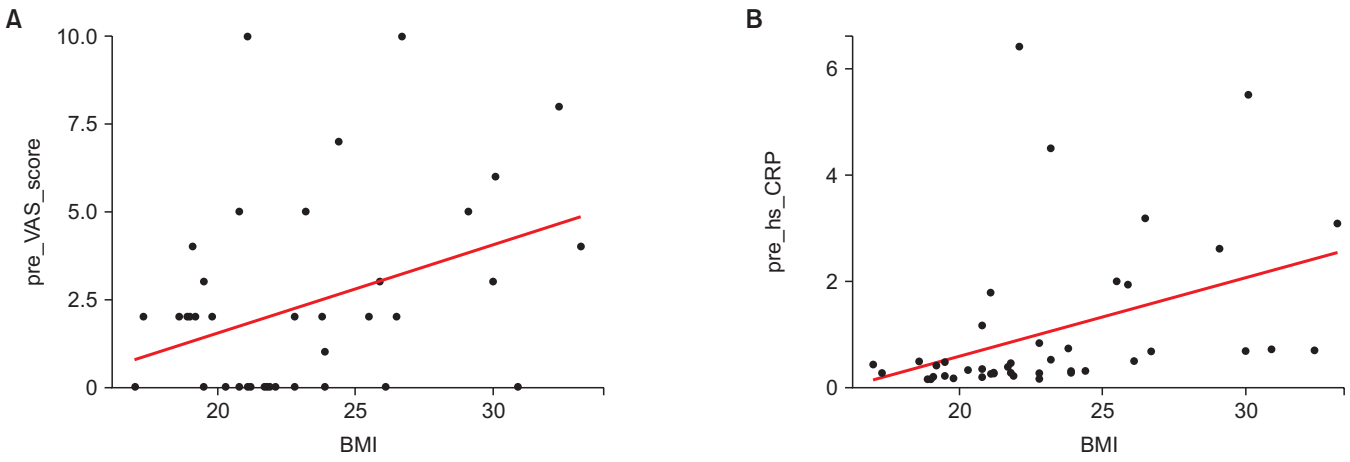

Fig. 2. Scatterplots for BMI and (A) preoperative VAS score and (B) preoperative hs-CRP level. (BMI: body mass index, pre-VAS: preoperative visual analog scale, pre-hs-CRP: preoperative high-sensitivity C-reactive protein)

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variable. Fig. 1 and Table 2 show pairs of variables that were significantly correlated.

1. BMI and preoperative VAS score and hs-CRP level

A statistically significant relationship between BMI and preoperative VAS scores was observed, with higher BMI associated with higher preoperative VAS scores (P=0.02).(Fig. 2. A) BMI was also significantly correlated with preoperative hs-CRP level in all patients (P=0.01).(Fig. 2. B)

Upon analyzing patient data by sex, women showed a more significant positive correlation between BMI and preoperative hs-CRP levels (P=0.00).(Fig. 3. A, Table 3)

We further analyzed patient data based on the eruption type of the extracted mandibular third molar. BMI was significantly correlated with the preoperative hs-CRP level only among patients undergoing extraction of a fully impacted mandibular third molar (P=0.00).(Fig. 3. B, Table 4)

2. Serum cortisol

As shown in Table 2, no correlations between serum cortisol levels and other variables were found. We examined patient data by sex and eruption type of the mandibular third molar but observed no associations between serum cortisol levels and other variables (P>0.05).

3. Preoperative anxiety and VAS score

We used the MDAS and APAIS questionnaires to assess patients' preoperative anxiety levels, and the scores of both questionnaires were positively correlated with each other.

The preoperative MDAS and VAS scores showed a significant positive correlation, especially among patients undergoing extraction of a fully impacted mandibular third molar (P=0.02).(Table 5)

4. Postoperative complications

Postoperative complications were assessed based on the hs-CRP levels and VAS scores of participants 1 day after the extraction surgery. Pearson's correlation indicated that the postoperative hs-CRP levels and VAS scores were strongly

Table 3. Pearson's correlation coefficient t-tests for BMI and preoperative hs-CRP levels in groups by sex

Variable 1	Variable 2	Group	Pearson's correlation coefficient	t-value	P-value
BMI	Pre-hs-CRP	Female	0.68	3.72	0.00**
BMI	Pre-hs-CRP	Male	0.17	0.85	0.40

(BMI: body mass index, Pre-hs-CRP: preoperative high-sensitivity C-reactive protein)
**P<0.01.

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Table 4. Pearson's correlation coefficient t-tests for BMI and preoperative hs-CRP levels in groups by eruption type of the extracted mandibular third molar

Variable 1	Variable 2	Group	Pearson's correlation coefficient	t-value	P-value
BMI	Pre-hs-CRP	Full impaction	0.73	4.50	0.00**
BMI	Pre-hs-CRP	Partial impaction	0.19	0.90	0.38

(BMI: body mass index, Pre-hs-CRP: preoperative high-sensitivity C-reactive protein)
**P<0.01.

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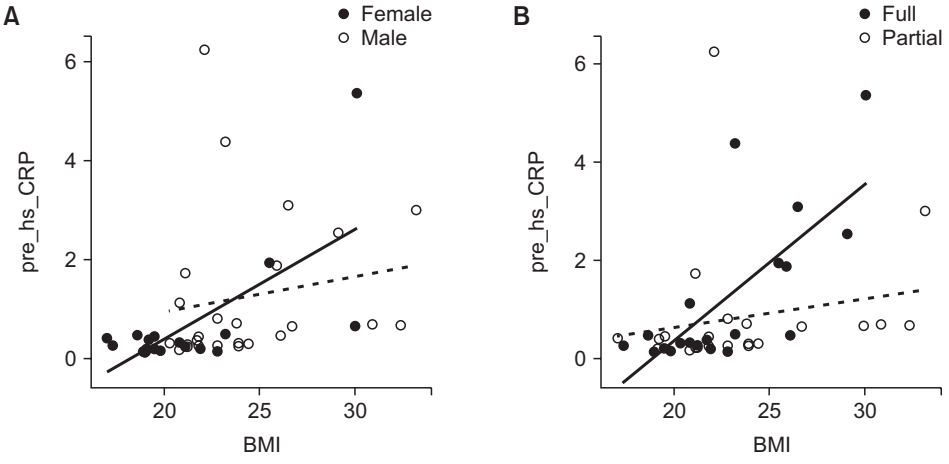

Fig. 3. Scatterplots for BMI and the preoperative hs-CRP level (A) among male and female and (B) among patients who underwent extraction of fully impacted and partially impacted mandibular third molars. (BMI: body mass index, pre-hs-CRP: preoperative high-sensitivity C-reactive protein)

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Table 5. Pearson's correlation coefficient *t*-tests for preoperative MDAS and VAS scores in groups by eruption type of the extracted mandibular third molar

Variable 1	Variable 2	Group	Pearson's correlation coefficient	*t*-value	*P*-value
Pre-MDAS score	Pre-VAS score	Full impaction	0.52	2.58	0.02*
Pre-MDAS score	Pre-VAS score	Partial impaction	0.11	0.51	0.61

(Pre-MDAS: preoperative Modified Dental Anxiety Scale, Pre-VAS: preoperative visual analog scale)
*P<0.05.
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Table 6. Linear regression with postoperative hs-CRP level as the dependent variable

Factors	ES	*t*-value	*P*-value
BMI	0.25	4.72	2.76e-05***
Eruption type[1]	3.70	2.04	0.04*
P-value			1.534e-9

(hs-CRP: high-sensitivity C-reactive protein, BMI: body mass index, ES: estimated coefficient)
*P<0.05, ***P<0.001.
[1]Eruption type: fully impacted=1, partially impacted=0.
Multiple R-squared=0.63, adjusted R-squared=0.61, F-statistic=34.67.
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correlated (P=0.00).(Table 2)

Multiple linear regression analysis without interception and with the postoperative hs-CRP level as the dependent variable indicated that the BMI and eruption type of the mandibular third molar were statistically significant independent factors among all measured variables.(Table 6)

Upon considering the postoperative VAS score as the dependent variable, BMI and eruption type were statistically significant independent factors among all measured variables. (Table 7)

IV. Discussion

Extraction of mandibular third molars is the most commonly performed oral and maxillofacial surgery. It is one of the most common causes of preoperative dental anxiety[3]. Preoperative patient anxiety can influence surgical outcomes through delayed or inadequate healing and postoperative complications[20].

Our findings indicate that higher BMI is associated with

Table 7. Linear regression for postoperative VAS score as a dependent variable

Factors	ES	*t*-value	*P*-value
BMI	0.16	6.63	5.46e-08***
Eruption type[1]	2.76	3.31	0.000193***
P-value			2.23e-14

(VAS: visual analog scale, BMI: body mass index, ES: estimated coefficient)
***P<0.001.
[1]Eruption type: fully impacted=1, partially impacted=0.
Multiple R-squared=0.78, adjusted R-squared=0.77, F-statistic=74.49.
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higher preoperative VAS scores and elevated inflammatory state based on the serum hs-CRP levels. BMI and hs-CRP levels were more positively correlated among women and patients undergoing extraction of fully impacted mandibular third molars. Among patients undergoing extraction of a fully impacted third molar, patients with high MDAS scores had a distinct tendency to feel more preoperative pain at the surgical site. We assessed postoperative complications based on postoperative serum hs-CRP levels and VAS scores. Multiple linear regression analysis indicated that patient BMI and eruption type of the extracted mandibular third molar are significant predictors of complications following mandibular third molar extraction.

Several studies suggest that obesity is positively associated with anxiety disorders[14,21,22] and specific phobias[23,24]. Further, anxiety disorders were more commonly observed among patients with obesity undergoing surgical treatment[22]. A positive correlation between anxiety and inflammation has also been reported[25]. Tayefi et al.[16] observed that the severity of anxiety disorders increased with increasing BMI among women. They also identified a positive association between serum hs-CRP levels and the severity of anxiety disorders. They concluded that BMI and hs-CRP levels were the strongest determinants of the severity of anxiety disorders. However, in our study, there were no statistically significant correlations between BMI and the two parameters of preoperative anxiety: MDAS and APAIS scores. Preoperative hs-CRP levels and preoperative anxiety, based on MDAS and APAIS scores, showed no significant association, but patient BMI and preoperative VAS scores were positively correlated.

Kim et al.[26] studied 37,303 patients and verified that serum CRP levels increased with BMI. Furthermore, there was a more significant correlation between serum CRP levels and BMI among women, which is consistent with the present

finding that women with higher BMI had higher preoperative serum hs-CRP levels.

The objective of our study was to determine whether there were correlations between serum cortisol levels and preoperative anxiety in patients undergoing mandibular third molar extraction. However, no statistically significant correlations were found. Cortisol is released from the adrenal cortex and responds to stress; it can be detected in urine, serum, and saliva. Previous studies have observed increased cortisol levels before dental treatment[27]. Anxious patients produce higher levels of cortisol than non-anxious patients[11]. Selimuzzaman et al.[28] reported similar findings upon studying the effects of surgical stress on serum cortisol levels in patients undergoing surgical treatment, with differences in hormonal responses between elective surgery and emergency surgery. Their study comprised 60 male subjects (age, 18-45 years) divided into three groups: 20 healthy controls (Group 1), 20 patients undergoing elective surgery (Group 2), and 20 undergoing emergency surgery (Group 3). Groups 2 and 3 were further divided into Groups 2A and 3A, which underwent blood sample collection 1 hour preoperatively; Groups 2B and 3B, which underwent blood sample collection 1 hour postoperatively; and Groups 2C and 3C, which underwent blood sample collection 24 hours postoperatively. The mean preoperative serum cortisol level of Group 2 was similar to that of Group 1. On the other hand, significantly higher serum cortisol levels were observed in Group 3 1 hour preoperatively and 1 hour postoperatively compared to those in Group 2. In our study, the mean preoperative serum cortisol level was 9.21±3.25 μg/dL, which falls within the normal range. The normal range of serum cortisol levels in adults is 5-23 μg/dL at 8 a.m. and 3-13 μg/dL at 4 p.m. All surgeries in the present study were elective, and the participants' blood samples were collected 1 hour preoperatively. Therefore, the participants may not have experienced elevated preoperative anxiety, which is consistent with the report of Selimuzzaman et al.[28].

Previous studies have reported positive correlations between the degree of preoperative anxiety and postoperative complications, such as pain and inflammation[7,8,29]. Ozalp et al.[30] and Feeney[31] found that state of anxiety among patients was a predictor of higher postoperative pain. However, contradictory findings have also been reported[3,32-34]. Kalkman et al.[34] constructed a study model to investigate the predictors of postoperative pain. They also added the APAIS questionnaire and the STAI (State-Trait Anxiety Inventory) test to measure patients' preoperative anxiety. However, preoperative anxiety level did not influence postoperative pain, and they concluded that patient sex, age, preoperative pain score, type of surgical procedure, and incision size were the chief predictors of postoperative pain. In keeping with the type of surgical procedure being a main predictor, our results showed that the eruption type of the extracted mandibular third molar was a main predictor of postoperative inflammation and pain. Compared to the extraction of a partially impacted mandibular third molar, extraction of a fully impacted mandibular third molar requires more osseous reduction and a wider full-thickness flap, which influences the complexity of the surgery. Therefore, differences in outcomes based on the eruption type of the mandibular third molar can be attributed to the difference in the type of the surgical procedure. Moreover, BMI was found to be a decisive predictor of postoperative inflammation and pain in the present study. Chung et al.[35] reported similar findings. They conducted a study to identify factors that can predict postoperative pain. A total of 10,008 consecutive ambulatory surgical patients were included, and the intensity of postoperative pain was assessed through telephone calls in the postanesthetic care unit, ambulatory surgical unit, and 24 hours postoperatively. Patients with severe pain had significantly higher BMI than those without severe pain. Therefore, Chung et al.[35] concluded that BMI was a significant predictor of severe postoperative pain.

In summary, surgeons could lower the risk of postoperative complications by considering patient BMI and eruption type of the mandibular third molar requiring extraction. Additional attention and strategies are recommended for patients with higher BMI undergoing mandibular third molar extraction.

The data of 43 patients were analyzed in this study. Our small sample size may have affected the results. The sizes of groups based on patient sex and eruption type of the extracted mandibular third molar were not standardized. Another potential limitation is that all surgeries were performed by two surgeons. In addition, the participants' blood samples were collected 1 hour before surgery and the time of each blood test varied. Cortisol levels are generally higher in the morning and lower at night. Non-invasive salivary cortisol has been recommended as a marker of cortisol levels of the body[36,37]. Salivary cortisol can reflect instantaneous changes in the body, but the concentrations of cortisol in serum and urine cannot. In addition, cortisol levels may be elevated during blood sample collection, as it is more invasive than urine and salivary sample collection. These factors may have influenced the study findings. Further studies with better control of these factors could provide more valid results and correlations between variables.

V. Conclusion

In the present study, patients with higher BMI showed elevated serum hs-CRP levels and higher VAS scores before mandibular third molar extraction. Patients undergoing extraction of a fully impacted mandibular third molar with high preoperative anxiety had higher preoperative VAS pain scores. The two main predictors of postoperative inflammation and pain were BMI and eruption type of the extracted mandibular third molar.

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Authors' Contributions

E.L. and S.o.H. has conceived and drafted the manuscript. E.L. and S.o.H. performed the surgery. Y.J.J., S.o.H., E.L., J.J., and M.H.L. reviewed the paper. All authors read and approved the final manuscript.

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Ethics Approval and Consent to Participate

The study was approved by the Institutional Review Board of Kyung Hee University Hospital at Gangdong (approval No. KHNMC 2022-08-031-004). Informed consent was obtained from all participated patients.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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