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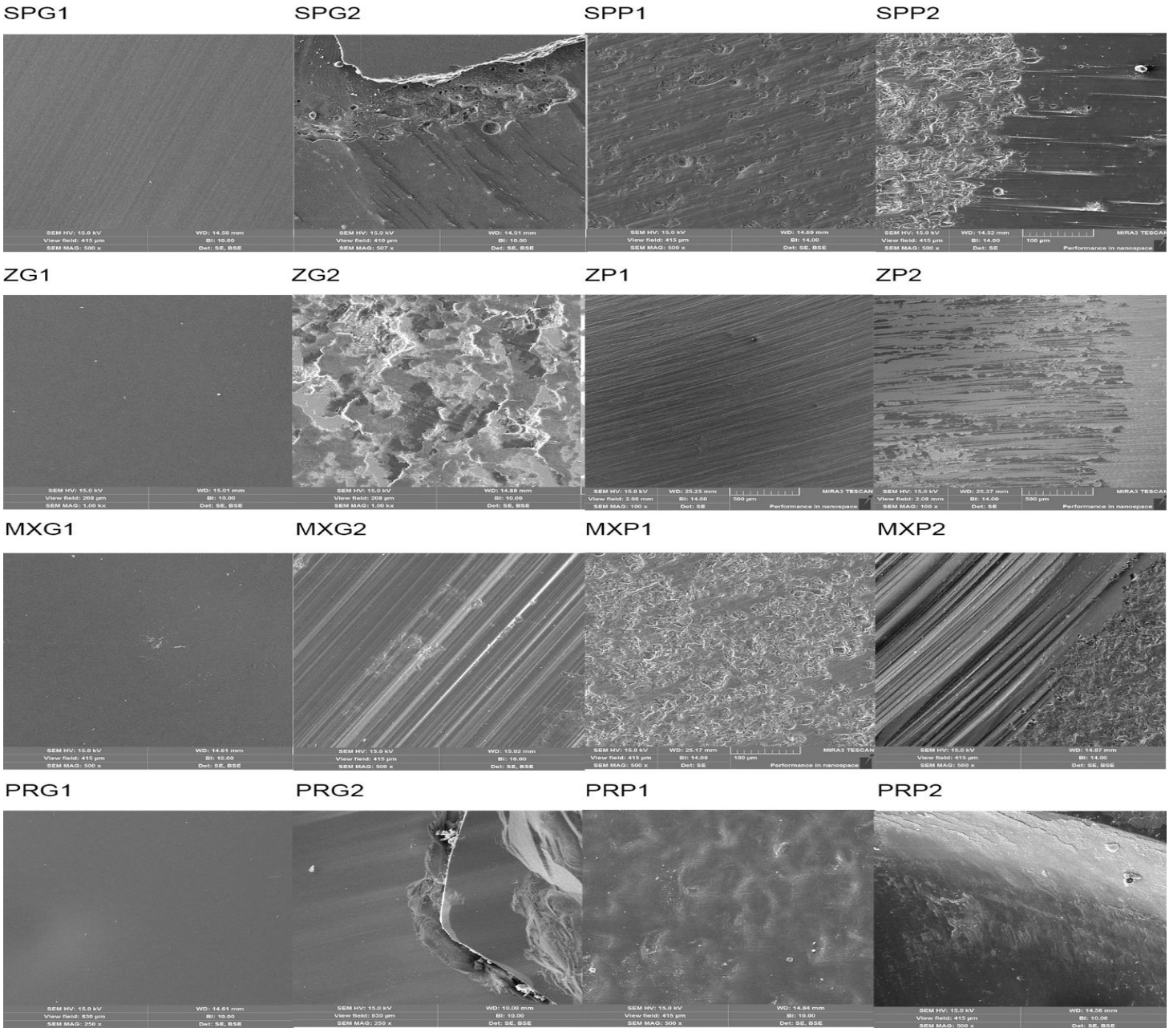

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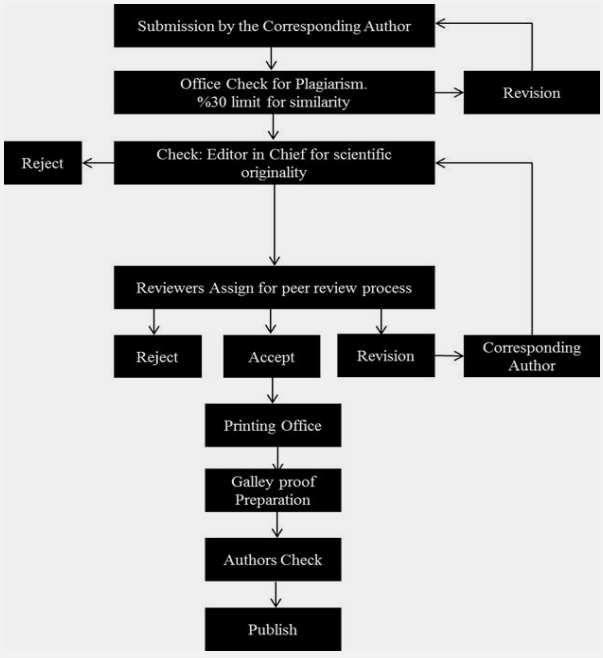

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Prevalence of Molar Incisor Hypomineralization: Meta-Analysis Study

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Abstract

Objective: Molar Incisor Hypomineralization (MIH) is defined as the hypomineralization of one or more first permanent molars, which may often also affect permanent incisors. The prevalence rate of MIH has been reported to vary between 2.5%-40.2% in various populations. This study aimed to reveal the general dimensions of MIH and to determine its prevalence in societies to plan long-term disease control programs.

Material and Methods: The database obtained by reviewing all studies on the relevant subject in English literature was examined and the prevalence was calculated using the random effect model. All studies were assessed in terms of publication bias while examining the heterogeneity and meta-regression by using sensitivity analysis.

Results: A total of 70 studies were included in the study and the prevalence of MIH was calculated to be 11.88% (95% CI 10.2%-12.4%). The sample size explained 99% heterogeneity.

Conclusion: This study has revealed that more strategies are needed for the preservation of dental health in this patient group due to the high prevalence of MIH, and there is a need for further prevalence studies involving isolated populations in different parts of the world.

Keywords: Meta-Analysis, Molar Incisor Hypomineralization, Pediatric Dentistry, Prevalence.

Introduction

Tooth development stages are affected by both genetic factors and environmental factors. Ameloblasts are highly vulnerable in the transition stage and the early maturation stage in particular. Their short-term or long-term exposure to environmental or systemic factors leads to enamel hypoplasia or hypomineralization. Structural deviations caused by an impairment during enamel formation result in permanent damage as there is no reshaping or repairing possibility. Damage to ameloblastic activity during the secretion or maturation phase causes impaired enamel formation (1). However, the sensitivity of ameloblasts to this damage is not the same at all stages of enamel development. All defects caused by damage to ameloblasts during enamel formation are called developmental enamel defects (2).

Enamel hypomineralization, a qualitative defect of enamel, is characterized by the demarcated opacity with normal enamel thickness and with the color varying from white to yellow-brown, soft porous enamel of poor appearance, fractures in the molars after the eruption, and hypomineralized enamel or enamel opacity with asymmetric opacity (2).

Etiological factors that lead to molar-incisor hypomineralization (MIH) by changing the organic or inorganic structure are still unknown. However, many factors are thought to be involved in its etiology and therefore, it is thought to have a multifactorial etiology. In a comprehensive study conducted in Southeast Sweden, 4,000 possibilities were found to potentially cause enamel opacity in six-year molars (3). Although MIH occurs in the third trimester and within the first year after birth, it can be noticed at the age of six, i.e. with the eruption of the first molar teeth, at the earliest. During this period, the medical history of the child may be forgotten and the socioeconomic status of the family may change (3).

To the best of our knowledge, genetic factors include enamelysin, Kallikrein (Klk 4), 22q11 gene deletions, and Runx2 suppression; medical factors include middle ear infection, chickenpox, asthma, pneumonia, prenatal urinary tract infection, infectious diseases, respiratory diseases, high fever, preterm labor, prolonged cyanosis during childbirth, neonatal hypocalcemia, and vitamin D deficiency; and systemic factors include severe malnutrition, bilirubinemia, chronic diseases, thyroid and parathyroid disorders, and maternal diabetes (3).

A study investigating the relationship between preterm labor and MIH has revealed that low birth weight and low gestation period might be effective factors. A 100-g increase in birth weight reduces the development of MIH by 4.5%, while gestation prolonged for one week decreases

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the development of MIH by 9.6%. Malnutrition, particularly breastfeeding for less than six months, causes the development of demarcated opacities in molars by five times more (4). The use of amoxicillin and erythromycin, vaccines, socioeconomic factors, and dioxins can be regarded as environmental factors (3).

Dioxins, which are known to be the most carcinogenic substances, are found in plastic materials. They accumulate in fatty tissues and pass into milk. According to the results of a study involving mice, bisphenol A (BPA), which the plastic industry cannot avoid using and is used in the production of the water bottles that we use in our homes, has been proven to cause MIH by affecting amelogenesis via the estrogen receptor alpha (ERα). In the same study, white opacity has been found in mandibular incisors in 75% of male mice and 31% of female mice (5).

Recent studies have revealed the correlation between gene expression and MIH. During the process of amelogenesis, the size, shape, shade, and caries susceptibility of teeth, and even enamel microhardness are under genetic control (6). Anomalies in the number of teeth and eruption, as well as enamel hypoplasia and hypomineralization, can be seen in 22q11 deletion syndrome (7).

In the literature, ameloblastin (AMBN), Tuftelin (TUFT1), ENAM gene rs3796704, and tuftelin-interacting protein 11 (TFIP11) rs5997096 have been revealed to correlate with MIH (8).

Molar-incisor hypomineralization is characterized by the morphological enamel defects caused by hypomineralization of systemic origin on the occlusal surfaces of first permanent molars and one third or more of the incisal surface of the incisors (9).

The term MIH refers to that at least one first permanent molar is affected and this is accompanied by incisors frequently (10). It has been reported that permanent canines, permanent second molars, and premolars may accompany this condition rarely. However, opacity seen only in incisors cannot be considered as MIH since it may also occur as a result of local factors (10). Therefore, researchers may have different views while establishing the diagnosis. European Academy of Paediatric Dentistry (EAPD) criteria are considered in recent studies on MIH (9). According to these criteria, the diagnosis of MIH is established on wet teeth after the teeth surfaces are cleaned meticulously. The age of eight is the best age for an accurate diagnosis. Since four first permanent molars and most of the incisors of children have already erupted at this age, four first permanent molars and eight permanent incisors are evaluated when they are wet in terms of the presence of demarcated opacity, fractures occurring after the eruption, atypical restorations, molars extracted due to MIH, and failure of the eruption in molars or incisors (9).

According to the results of the studies, the prevalence of MIH varies between 2.5%- 40.2% all over the world, which has been reported to be between 3.6%–37.5% in Europe, 40.2% in Brazil, and 2.8% in Hong Kong (1). However, different evaluation criteria are used in the diagnosis of MIH in the studies, and therefore, the prevalence of MIH cannot be calculated accurately due to the differences in these criteria.

This study aimed to evaluate the prevalence of MIH reported in epidemiological studies carried out considering the EAPD 2003 criteria, and to provide a more reliable source of the prevalence of MIH by conducting a meta-analysis on the study data obtained.

Material and Methods

Study Selection and Data Collection

Preferred Reporting Items for Systematic Reviews (PRISMA) and Meta-analysis of Observational Studies in Epidemiology (MOOSE) criteria were used in the preparation of systematic review and meta-analysis (11,12). PubMed, Google Scholar, Ovid Medline, and Web of Science Core Collection databases were scanned on 30 September 2020 to identify eligible studies.

The reviews achieved during the scanning of the sources and databases of all the articles were evaluated in terms of whether they were eligible for the study. Studies that included classification according to EAPD criteria and prevalence value, even if their main objective was not to determine MIH prevalence, were evaluated. In the case of missing data, the authors of the relevant study were contacted and missing data were tried to be obtained. The following keyword was scanned in the study: MIH=(molar OR incisor OR hypomineralization AND =(prevalence OR incidence OR incident), Molar incisor hypomineralization=(molar OR incisor OR hypomineralization AND =(prevalence OR incidence OR incident), Enamel Hypomineralization=(enamel OR hypomineralization AND =(prevalence OR incidence OR incident).

Studies obtained through these databases were selected by two researchers (CÖ, BBA) independently by firstly checking the titles and abstracts and then full-text articles. In case of a discrepancy in the selection, or if there were any doubts, the opinion of another researcher (APM) was obtained to decide whether the relevant article should be included in the study. The agreement between the two researchers in the selection of articles was analyzed statistically. The article selection process is summarized in the PRISMA flowchart presented in Figure 1.

Evaluation of the studies in terms of bias

All studies to be included in the analysis were evaluated using a bias score that was developed by the research team and took into account representational power, measurement standards, and missing data. (Table 1.) Studies with a score of 2 and above were regarded to be problematic in terms of representational power. Therefore, these studies were evaluated as high risk of bias, and those with a score of 0–1 as low risk of bias. Statistical analyses were performed after eliminating the studies assessed to have a high risk of bias. In the evaluation of the results, the studies assessed to have a low risk of bias were focused on.

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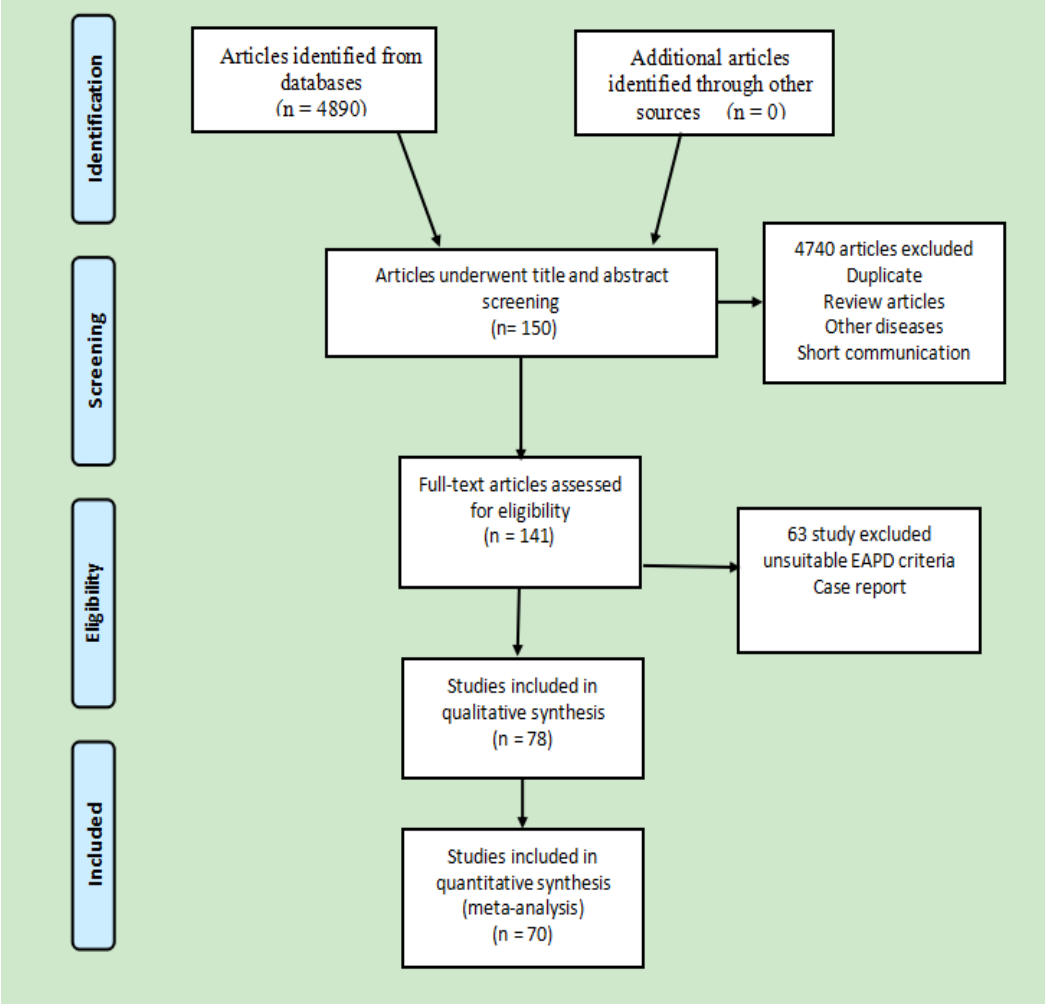

Figure 1. Prisma flowchart

Table 1. Bias score

Criteria	Point
Sampling potential is poor	2
Sampling is not fully representative	2
Probabilistic sampling	2
Selective age (including children less than 6 years old)	2
Missing data (<10%)	1
Missing data (<20%)	2
Small scale work (<100 persons)	1
Small scale work (<10 persons)	2

Calculation of prevalence and obtaining numerical data

Crude prevalence and numerical data that were not standardized by age were used in the calculation of prevalence. The reason for this was that it was not clear which standard population was based on in calculating the standardized values in each article or they were not standardized for the same population. Data obtained from studies in which EAPD criteria were used in the diagnosis of MIH were included in this study.

Statistical analysis

The agreement between the observers was evaluated using Cohen's kappa coefficient for the article selection and bias scores, which were made independently from each other. Kappa values were interpreted as follows: values ranging between 0.41– 0.60 as moderate, 0.61–0.80 as substantial, and above 0.80 as almost perfect agreement (13). Analyses were performed by combining the studies remaining after the exclusion of the articles with a biased score higher than 2. The meta-analysis of the data was calculated using the fixed-effects model and the random-effects model, but the results of the random-effects model were used in the interpretation.

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The heterogeneity between studies was evaluated using Cochran's Q and I2 test statistics. With a conservative approach in the Cochran's Q test statistics, a p-value <0.10 was interpreted as indicating statistically significant heterogeneity. The value of I2>75% was interpreted as high heterogeneity. A funnel plot was drawn to show small-study effects, publication bias, and other possible reasons for heterogeneity. The sensitivity analysis was assessed based on the change occurring in the result following the exclusion of a study at a time.

RevMan 5.4.1 (Cochrane Training, https://www.cochrane.org/) was used as the analysis tool. In the analysis, "psych", "metaphor", and "meta" packages were used. Except for Cochran's Q statistics, other p values <0.05 were considered statistically significant.

Results

A total of 4,890 studies were reached as a result of the database scan. Among them, 968 studies were found to be the same due to the evaluation of different databases. The remaining 3,840 studies were reviewed, and 3,699 studies that were found to be unrelated to the subject were eliminated.

Thirty studies in which EAPD criteria were not used at the time of MIH diagnosis and eight studies that were found to have a high bias score (>2) were excluded from the study.

According to the results of the review of studies on the evaluation of the MIH prevalence, a total of 70 studies (n=93519) meeting the study criteria and 68 articles presenting the results of these studies were reached (Fig 2. Forest plot graphic) The agreement between the raters was found to be perfect both in the selection of articles and bias scoring of selected articles (Cohen's kappa coefficient was 0.95 (95% Confidence Interval [CI] 0.88–1) for article selection, and 0.97 (95% CI 0.92–1) for bias scoring).

The mean prevalence of MIH was found to be 10.1% (95% CI 10.2%-12.4%) in the random-effects meta-analysis of 70 studies involving MIH prevalence data. The heterogeneity between studies was found to be significantly high (i2=99%). The Funnel plot shows an asymmetrical pattern in the whole group (p>0.10). No major problems were detected in the sensitivity analysis. The funnel plot of the study and forest plot are presented in Figure 2 and Figure 3, respectively.

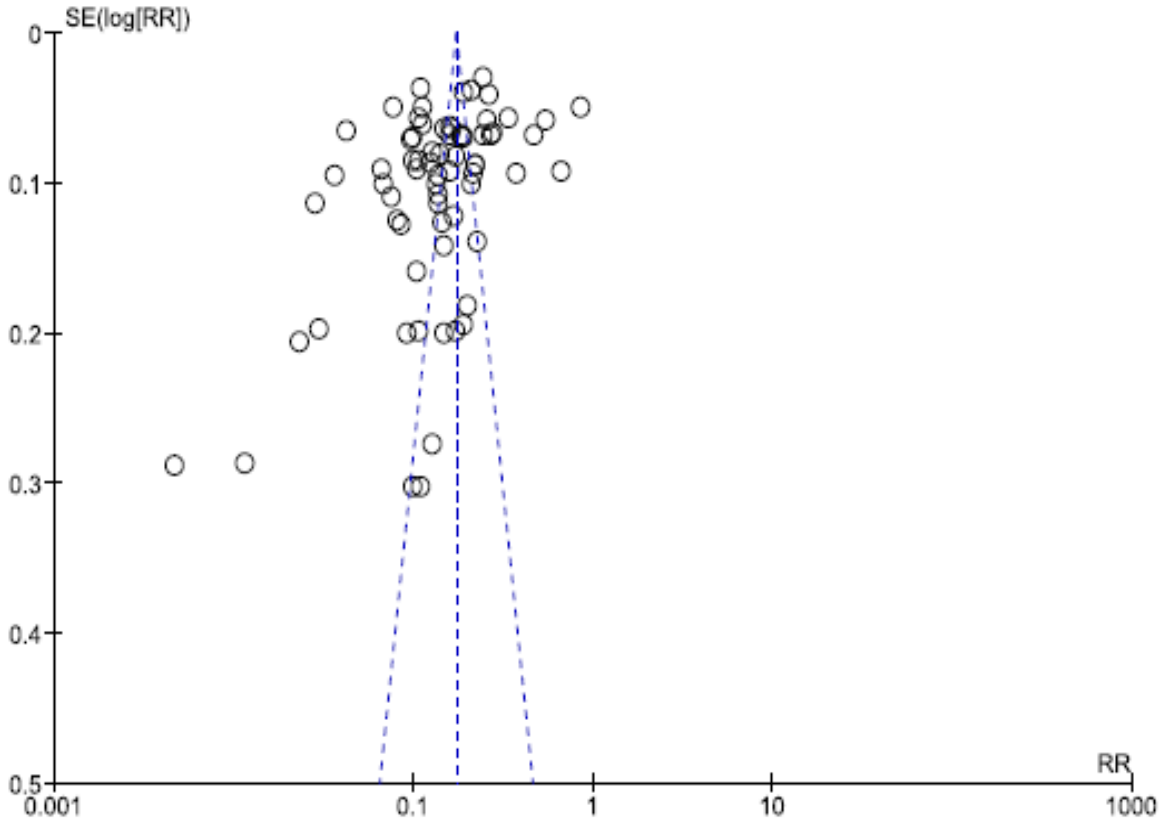

Fig 2. Funnel plot graphic

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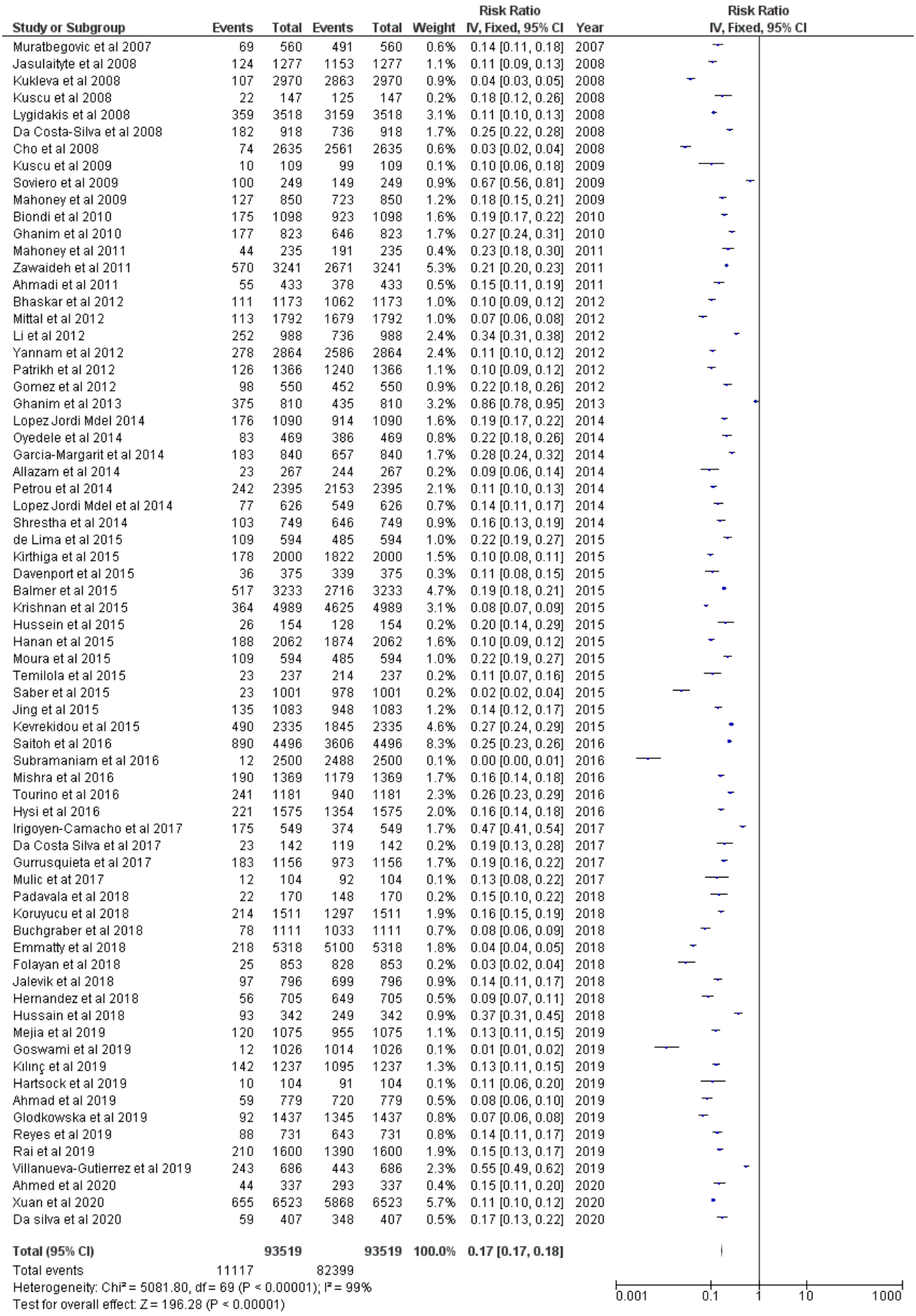

Fig. 3. Forest plot graphic

Discussion

The first epidemiological study of MIH was conducted among Swedish children in the late 1970s. In this study, "cheese" first molars with opacity varying from cream-white to yellow-brown were defined (14). In the first epidemiological studies conducted, there was no consensus among researchers in terms of diagnostic criteria and identification. Various terms have been used in the past to describe this pathology: non-endemic stained enamel (15), idiopathic hypomineralization of the enamel of the first permanent molars (16), hypomineralization of the permanent first molars not caused by fluoride (17), and molar-incisor hypomineralization (10). In 2003, EAPD agreed on the use of the latest terminology and also determined the evaluation criteria (9).

Although its definition was made based on various criteria until 2003, diagnostic criteria determined by the EAPD in that year was started to be used in epidemiological studies. The results of epidemiological studies using EAPD criteria are more reliable since the development and use of common evaluation criteria ensure consensus among researchers. Therefore, the data of studies using the EAPD criteria were analyzed in the present study.

In this meta-analysis, the prevalence of MIH was found to be 11.88% by the assessment of 93519 individuals in 70 studies. The result obtained was compatible with the results of several previous studies (1,10,18,19,20,21). On the other hand, MIH prevalence was reported to be lower in several studies (22,23). The prevalence of MIH could have been found to be lower, as children under six years of age were evaluated in these studies.

Following the analysis, the review of studies reporting low MIH prevalence rates showed that the prevalence was higher in studies involving children under 10 years of age. In studies where the prevalence was reported to be very low, the age group was found to be older (>15 years). Similarly, Yannam et al. (24) found that the prevalence of MIH was lower in children older than 10 years of age and attributed this to the fact that MIH diagnosis cannot be established due to tooth extraction and treatments. Mishra and Pandey (25) reported that the prevalence of MIH increased in children aged eight to nine years due to the increase in the post-eruptive breakdown.

It can be difficult to distinguish between MIH and enamel hypoplasia in cases where decay occurs or losses due to masticatory forces occur in the affected first permanent molars. In children with high caries activity, MIH can be masked by extensive caries or restorations. Enamel hypoplasia and MIH may coexist but they can be distinguished at the histological level. Therefore, it is easier to diagnose MIH when the first permanent molars and permanent incisions have newly erupted. The ideal age at which the incisors and first permanent molars can be seen fully in the mouth and for the diagnosis of MIH is eight years (10). We believe that different results have been obtained in calculating the prevalence of MIH, as the age was not evaluated or it was given as missing information in the studies.

Conclusion

To conclude, the prevalence of MIH has been found to be 10.1% in the present meta-analysis, and it has been revealed that there is a need for further prevalence studies involving isolated populations in different parts of the world. Moreover, more strategies for the preservation of dental health need to be developed in areas with high MIH prevalence.

Author Contributions: CÖ, BBA, APM: Project design, Review of the literature, data collection and analyzes **CÖ;** Writing of the article and Revisions

Ethical issues: All authors declare originality and ethical approval of research. Responsibilities of research, responsibilities against local ethics commission are under the authors responsibilities. The study was conducted under defined rules by the local ethics commission guidelines and audits.

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A retrospective examination of the effects of regional anesthesia methods applied for postoperative pain control on analgesic consumption after lower extremity surgery

Mehmet Kenan Erol[1]*

Abstract

Objective: If preferable, the regional anesthesia is a more preferred method than general anesthesia. The preference for regional anesthesia increases as postoperative recovery is quicker, hospitalization is less and hospital costs are low.

Material and methods: We retrospectively evaluated the hemodynamic findings, postoperative pain, hospital, and intensive care stay in patients aged 18-80 who underwent lower extremity surgery with regional anesthesia in the last 1 year. We divided the cases into 3 groups; Group 1 (n =114) patients with a peripheral nerve block, Group 2 (n =104) spinal anesthesia, and Group 3 (n =81) epidural anesthesia.

Results: The difference between group 1 and 2, age hospitalization, and time of stay in intensive care was statistically significant. (P=0.021) (P=0.000). The difference between group 1 and 3 Intensive care unit stay was statistically significant (P = 0.003). The difference between the length of stay in the intensive care unit between groups 2 and 3 was found as statistically significant (P = 0.000). There was no significant difference in terms of hospital stay. Group 1 was found to have the shortest duration of intensive care stay.

Conclusion: In lower extremity surgeries, peripheral nerve blocks may have provided more hemodynamic stability and longer analgesic effect compared to central blocks.

Keywords: Regional Anesthesia, Lumbar block, Sciatic block.

Introduction

Nowadays, regional anesthesia is more preferred, especially because of the increase in outpatient surgeries. The preference for regional anesthesia increases as postoperative recovery is quicker, hospitalization is less and hospital costs are low (1).

In regional anesthesia compared to general anesthesia; Side effects such as hemodynamic instability, postoperative cognitive impairment, respiratory depression due to opioids, drowsiness, and nausea and vomiting are less common (1).

Regional anesthesia can be divided into three groups: central blocks in which epidural and spinal blocks are performed, peripheral nerve blocks performed by injecting an anesthetic substance into the nerves or plexuses, and area blocks where anesthetic drug injections are made into the surgical area and surrounding tissues (2).

The most important advantage of peripheral nerve blocks against general anesthesia and other regional anesthesia methods is that anesthesia is limited to the area innervated by the nerve (2).

Lower limb blocks are technically challenging for anatomical reasons and require clinical experience. Many of these blocks were traditionally performed with paresthesia, loss of resistance, or field block techniques in the past, with varying success rates. Today, there have been many developments in needles, catheters, and nerve stimulators, and ultrasound has come into use in peripheral blocks (3).

Nerve stimulator and ultrasound can be used as a complement to each other or separately. Ultrasound has gained importance in peripheral nerve and plexus blocks. It allows local anesthetic to be administered around the nerve at a lower dose by being observed. (3)

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In our study, we aimed to retrospectively evaluate the effects of regional anesthesia performed in lower extremity surgeries on hemodynamic, postoperative pain, hospital, and intensive care stay.

Material and Method

After the approval of the Ethics Committee of Harran University Faculty of Medicine (Decision 09.03.2020 -05-06), we retrospectively evaluated the hemodynamic findings, postoperative pain, hospital, and intensive care stay in patients aged 18-80 who underwent lower extremity surgery with regional anesthesia in the last 1 year.

Those who are allergic to the drugs in the study, those with bleeding diathesis, neuromuscular and spinal deformities, infection at the application site, neurological disease, mental disorder, patients who do not accept regional anesthesia, patients under 18 and over 80 years of age, surgery duration longer than four hours were excluded.

We divided the cases into 3 groups; Group 1 (n =114) who patients with peripheral nerve block, Group 2 (n =104) spinal anesthesia, and Group 3 (n =81) epidural anesthesia.

The Visual Analogue Scale (VAS) was used to determine the need for analgesia.

After the patients were monitored, the anesthesia method was applied.

In the spinal anesthesia method, while the patient was in a sitting position, 0.5% 3.5 ml Bupivacaine was applied to the subarachnoid space under sterile conditions from the L4-L5 region.

In the epidural anesthesia method, while the patient was in a sitting position, an epidural catheter was inserted under sterile conditions, and a mixture of 0.5% 25 mg Bupivacaine , 50 mcg Fentanyl, and 50 mcg Lidocaine were applied to form a block at the T8 level.

In the lumbar plexus-sciatic nerve block, a 100 mm stimulation needle (D22G, Stimuplex, B. Braun, Germany) was used to provide 2 Hz electrical stimulation, provide 2 Hz electrical stimulation with a starting current of 1 mA and a pulse duration of 0.1 ms. The contraction of the quadriceps femoris and gastrocnemius in response to a current of <0.3 mA indicated that the injection site was reached. When no blood or cerebrospinal fluid aspiration was confirmed, 0.5% and 30 ml of bupivacaine were injected for the lumbar plexus block and the sciatic nerve block, respectively.

Postoperative analgesia was not administered in any of the groups. Hemodynamic changes were evaluated using the maximum rate of variation calculated using the following formula: maximum rate of variation = (maximum-minimum) / pre-anesthetic value.

Posteparif VAS score was checked at 2nd, 6th, and 12th hours. VAS scores range from 0 to 10, with 0 being painless and 10 being the worst pain imaginable.

Statistical analysis

Continuous data are presented as means and standard deviations. Categorical data were presented as percentages or frequency. Comparisons were made using one-way analysis of variance followed by posthoc analysis or chi-square test. Ordinary data compared using the Anova test. All statistical analyzes were performed using SPSS 23.0 software (SPSS, Chicago, USA). P <0.05 was considered statistically significant.

Results

Group 1 (n= 114), Female=42 (36.8%), Male =72 (63.2%), mean age 51.6±20.97 years, hospital stay 4.94±4.05 days, and the duration of intensive care stay was 0.26±0.82 days.

Group 2 (n= 104), F = 43 (41.3%), M = 61 (58.7%), mean age 63.35±16.76 years, hospital stay 5.34±2,9 days, and the length of stay in the intensive care unit was 0.85 ±2.35days.

Group 3 (n= 81), Female= 23 (28.4%), Male= 58 (71.6%), mean age 45.83±22.5 years, hospital stay 4.85±2,81days, and the length of stay in the intensive care unit was 0.87±0.6 days.

Gender, age, and ASA characteristics of the patients were similar (Table1).(Figure 1)

The difference between groups 1 and 2, age, hospitalization and length of stay in intensive care was statistically significant. (P = 0.021) (P = 0.00).

The difference between group 1 and 3 Intensive care unit stay was statistically significant. (P = 0.003)

Group 1 was found to have the shortest duration of intensive care stay.

The difference in heart rate, mean arterial pressure, and maximum variation ratio was statistically significant between the 3 groups. (P = 0.00) Table 2

The preoperative VAS score was not different between the 3 groups.

While the 2nd-hour VAS score was similar between Group 1 and Group 3, it was significantly higher in Group 2 (P = 0.00).

While the 6th hour and 24th-hour VAS score was significantly lower in Group 1 (P = 0.00), there was no statistically significant difference between Group 2 and Group 3 (P = 0.69).

No significant difference was found in terms of other findings.

Table 1. General informations of patients

	Group 1 (n=114) Mean±STD	Group 2(n=104)	Group 3(n=81)	P-Value
Gender	F = 42 (36.8%) M = 72 (63.2%)	F = 43 (41.3%) M = 61 (58.7%)	F = 23 (28.4%) M = 58 (71.6%)	P=0.62
Mean Age (year)	51.6 ±20.97	63.35 ±16.76	45.83 ±22.5	Grpup1-2 P=0.021 Group 2-3 P=0.59 Group 1-3 P=0.67
Hospital Stay (day)	4.94 ±4.05	5.34±2,9	4.85±2,81	Group 1-2 P=0.00
ICU Stay (day)	0.26±0.82	0.85±2.35.	0.87±0.6.	Group 1-2 P=0.00

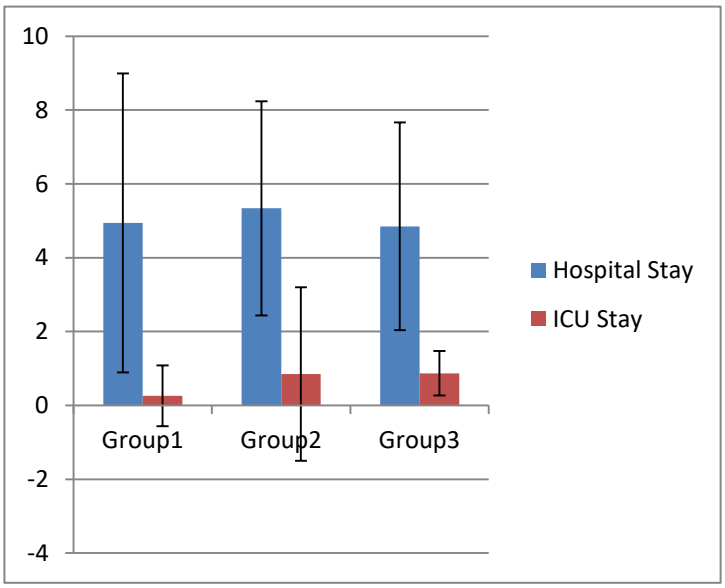

Figure 1. Comparison of Hospital and ICU stay (days)

Table 2. Maximum Variation Rate Comparison

	Group 1 (n=114) peripheral nerve block	Group 2 (n =104) spinal anesthesia	Group 3 (n =81) epidural anesthesia	P-value
Systolic Blood Pressure	0.27 (0.25-0.29)	0.40 (0.35-0.45)	0.35(0.30-0.40)	P=0.00
Diastolic Blood Pressure	0.21(0.19-0.23)	0.36(0.34-0.39)	0.30(0.29-0.32)	P=0.00
Heart Rate	0.23(0.20-0.26)	0.39(0.34-0.42)	0.32(0.29-0.33)	P=0.00

Discussion

Nerves that innervate the lower limb exit from the lumbar and sacral plexuses. The lumbar plexus consists of the anterior parts of the first four lumbar nerves; often takes branches from T12 and sometimes from L5. The plexus is located in the psoas compartment between the psoas major and quadratus lumborum muscles. The lower components of the plexus L2-3 and L4 innervate the anterior and inner thigh region. The anterior parts of L2-3 and L4 form the obturator nerve, the posterior parts of the same nerves form the femoral nerve. The lateral cutaneous nerve consists of the posterior parts of L2 and L3. The posterior cutaneous nerve and the sciatic nerve of the thigh are formed by the addition of branches in the anterior parts of S1-2-3 and L4-5, respectively. These nerves pass together through the pelvis and the large sciatic foramen and are blocked using the same technique. The sciatic nerve is the combination of two major nerve trunks.

The tibial nerve (anterior branches of the anterior parts of L4-5 and S1-2-3), the main peroneal (posterior branches of the anterior parts of L4-5 and S1-2-3) are nerves. In or above the popliteal fossa, the tibial nerve splits inward and the main peroneal nerve outward. (2)Peripheral nerve blocks are used in postoperative analgesia when general anesthesia is not desired or contraindicated. Less side effects, more stable hemodynamics and longer analgesic effect than central blocks cause peripheral nerve blocks to be preferred (4).

Hemodynamic instability, such as changes in heart rate and blood pressure during intubation and extubation, may increase the risk of vascular events, especially in elderly patients. Hemodynamic instability was found the most in the spinal anesthesia group.

The difference in the maximum variation ratio was found to be the lowest in the peripheral nerve block group. This shows that the peripheral nerve block is safer in terms of hemodynamic instability (5).

VAS score was found to be lower in the peripheral nerve block group than the spinal anesthesia and epidural anesthesia group. This shows that the analgesic effect of the peripheral nerve block lasts longer than the epidural anesthesia and spinal anesthesia groups (6).

Aldahish et al. compared combined lumbar plexus plus sciatic nerve blocks with epidural anesthesia in terms of intraoperative anesthesia and postoperative analgesia. Similar to our study, the results showed effective anesthesia in both groups and the analgesic duration was longer in the peripheral nerve block (7).

Davies et al. compared epidural anesthesia with femoral block anesthesia. Similar to our study, the duration of analgesic was found to be longer in the peripheral block (8).

Greengrass et al. Compared peripheral nerve block with epidural anesthesia in their study. Similar to our study, they showed that there was a longer analgesic effect in the peripheral nerve block group (9).

In a similar study conducted by Horasanlı et al., patients who underwent peripheral nerve block showed more hemodynamic stability, less side effects and a longer analgesic effect time compared to patients undergoing epidural anesthesia. This shows similar results to our study (10).

One of the limitations of our study is that it is retrospective and that data was searched from files.

Conclusion

In lower extremity surgeries, peripheral nerve blocks may have provided more hemodynamic stability and longer analgesic effect compared to central blocks.

In addition, although no significant difference was found in terms of length of hospital stay, the duration of intensive care stay was found to be shorter in the peripheral nerve block group. This may indicate that peripheral nerve blocks may be more preferable in lower extremity surgeries. More studies are needed in this area.

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Author Contributions: MKE: Project design, Patient examinations, Review of the literature, data collection and analyzes **MKE;** Writing and Revisions

Ethical issues: All authors declare originality and ethical approval of research. Responsibilities of research, responsibilities against local ethics commission are under the authors responsibilities. The study was conducted under defined rules by the local ethics commission guidelines and audits.

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KISS1, P53, and PTEN immunoexpressions and prediction of malignancy in endometrial intraepithelial neoplasia lesion within endometrial polyp

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Abstract

Objective: Aim of this study to evaluate the usefulness of phosphase and tensin homologous deleted on chromosome 10 (PTEN), p53, and kisspeptin (KISS1) immunoexpressions in predicting malignancy in endometrial intraepithelial neoplasia within the endometrial polyps.

Material and method: This cross-sectional study was based on chart data from a convenience sample of patients who underwent probe curetage at the Gynecology and Obstetrics Clinic of Başkent University Ankara and Konya Practice and Research Hospitals, Turkey. A total of 169 patients were allocated into 5 groups, comprising the EIN-p group: 62 patients with an endometrial intraepithelial neoplasia lesion within an endometrial polyp, EC group: 17 patients with an endometrial carcinoma, EP-h group: 30 patients with hyperplasia on the background of the polyp but no atypia, EP group: 30 patients with endometrial polyps, and NE group: 30 patients with a normal (proliferative) endometrium. P53, PTEN, and KISS1 expressions between the groups were evaluated.

Results: In the EIN-p and EC groups, P53 and KISS1 expressions were moderate or strong. In the NE, EP and EP-h groups, KISS1 was weakly stained and P53 expression was negative. The number of patients with strong p53 and KISS1 expressions in the EC group was higher and this difference was statistically significant ($P < 0.001$). With PTEN immunostaining, the EC and EIN-P groups were weakly stained, whereas the NE, EP, and EP-h groups had moderate or strong staining. Strong staining rates were higher in patients in the NE and EP groups than in the EP-h group ($P < 0.001$).

Conclusion: In addition to the literature about P53 and PTEN, according to the data obtained herein, it was speculated that KISS1 may play an important role in the malignant transformation of endometrial polyps and it might be used as a predicting marker in this patient group.

Keywords: P53; PTEN; KISS1; Endometrium; EIN; Polyp

Introduction

Endometrial polyps are focal overgrowths of the endometrial mucosa that progress towards the cavity and are generally benign (1). Although they often show spontaneous regression, they rarely show premalignant or malignant changes (2). The rate of malignancy potential of endometrial polyps ranges from 0.3%–4.8% (3).

Endometrial hyperplasia, particularly with atypia, is a significant clinical concern because it can be a precursor to endometrial cancer. Atypical hyperplasia (EIN), as a precancerous lesion, requires a different approach in treatment than other types of hyperplasia and adenocarcinomas.

EIN contains many of the genetic changes seen in endometrioid endometrial carcinomas. The most recent World Health Organization classification of ECs (2014) was based mostly on morphologic features (4). The most common genetic alterations encountered in endometrioid (type 1) ECs are mutations in phosphase and tensin homologous deleted on chromosome 10 (PTEN), Kirsten rat sarcoma virus homolog, catenin beta-1 gene, and phosphatidylinositol-4,5-bisphosphate 3-kinase, catalytic subunit alpha, and microsatellite instability. In contrast, type 2 ECs, which are mostly serous carcinomas, show consistent TP53 mutations and human epidermal growth factor receptor-2/neu gene amplification (5,6).

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However, p53 mutation can be seen in 12%–30% of endometrioid endometrial cancers.

To date, many factors, including clinical and biological, have been studied to predict premalignant or malignant changes of endometrial polyps (7,8). In recent years, immunhistochemical studies conducted to predict the risks of malignancy of endometrial polyps have attracted great attention. Studies on the immune expression of tumor supressor genes, such as p53 and PTEN, have been more common (7,9). P53 was one of the first tumor suppressor genes to be described. However, in recent years, it has been understood that it is a promoter oncogen (10). PTEN, which modulates cell proliferation, cell apoptosis, and migration, was isolated as a bit tumor suppressor gene in 1997 (11). In addition to these 2 biological factors, kisspeptin (KISS1) protein expression has also been added in recent years for endometrial malignancies (12,13). However, it is still a matter of debate as to how the KISS1 protein plays a role in the regulation of different organ malignancies (14).

Therefore, in this study, it was aimed to evaluate the usability of PTEN, P53, and KISS1 immunoexpressions in predicting malignancy in endometrial intraepithelial neoplasia within the endometrial polyps, and shed light on this for future studies on this subject.

Material and method

This cross-sectional study was based on chart data from a convenience sample of patients who underwent probe curetage at the Gynecology and Obstetrics Clinic of Başkent University Ankara and Konya Practice and Research Hospitals, Turkey, between January 2010 and December 2019. The study protocol was approved after obtaining the necessary permissions from Başkent University Ethics Committee (register number KA19/257).

In the study period, the pathology reports were reviewed and 62 patients of endometrial intraepithelial neoplasia lesion within endometrial polyp (EIN-p group), 17 patients with EC arising from endometrial polyps (EC group), 30 patients with hyperplasia on the background of the polyp but no atypia (EP-h group), 30 patients with endometrial polyps (EP group), and 30 patients with normal (proliferative) endometrium (NE group) were included the study. Patients in the EIN-p group included those with hysterectomy in the hospital after probe curettage. Thus, the results of the hysterectomy pathologies of patients in the EIN-p group were compared in terms of immunostaining according to malignancy, myometrial invasion, and depth of invasion. Sections were incubated at 56 °C for 24 h and deparaffinized in xylene, followed by rehydration by passing through descending concentrations of alcohol (100%–70%). The sections were then placed in 0.5% hydrogen peroxide in methanol for 5 min to block endogenous peroxidase activity. Antigen retrieval was performed by heating the sections in trisodium citrate buffer (10 mM of sodium citrate, pH 6.0) for 10 min in a microwave. The slides were rinsed 3 times in deionized distilled water and 0.3% hydrogen peroxidase was applied to the sections for 30 min to block endogenous peroxidase activity. The slides were then washed again in phosphate-buffered saline (PBS) for 2–3 mins. To reduce non-specific background staining, Ultra V Block (Thermo Scientific, Cheshire, UK) was applied to the sections for 5 min. The primary antibodies used were PTEN and mouse monoclonal antibody (PTEN (a2B1): sc-7974), Santa Cruz, CA, USA, at a dilution of 1:100 overnight), p53 and mouse monoclonal antibody (p53(DO-1): sc-126), at a dilution of 1:100 for 2 h), and KISS-1 and mouse monoclonal antibody (KISS-I (24-Q): sc-101246 at a dilution of 1:100 for 2 h). After incubation, the primary antibody slides were washed with PBS for 5 min. Biotinylated goat anti-polyvalent (Lab Vision Corp., Fremont, CA) was applied and washed in PBS. Next, streptavidin peroxidase (Lab Vision Corp.) was applied and the slides were incubated for 15 min at room temperature. The immunoreaction was visualized using 3,3'-diaminobenzidine-tetrahydrochloride-dihydrate (Thermoscientific Dako, Glostrup, Denmark) as a chromogen. The slides were counterstained using Mayer's hematoxylin solution and mounted. The specificity of the staining was confirmed using a positive control.

All of the slides were analyzed by 2 pathologist observers. PTEN expression was observed both in stromal cells and endometrial glandular cells in the cytoplasm; however, stromal cells had a stronger immunoreactivity for PTEN than the glandular cells. Stromal staining was present in all of the study groups (EC, EIN-p, EP-h, EP, and NE). However, glandular expression was heterogenous. For rating of the PTEN staining, that performed by Karuna Garg et al. was used (15). PTEN expression was graded as 2 in normal endometria. Weakly staning of PTEN expression was mostly seen in the EC and EIN-p groups (Figure 1). KISS1 staining was graded by taking into account the staining intensity and percentage of staining. KISS proteins were mainly located in the cytoplasm of glandular epithelia. The staining intensity was evaluated by applying the following scale: 0 for negative, 1+ for low, 2+ for moderate, and 3+ for strong intensity. The scoring criteria of the percentage of stained cells were: 0 for <10%, 1 for 10%–25%, 2 for 10%–50%, 3 for 51%–80%, and 4 for >80%. The final score was calculated as the product of the percentage and staining intensity, resulting in weak (0–2 points), moderate (3–6 points), and strong (7-points) KISS-1 expression (16) (Figure 1). The expression of p53 was determined by counting 500 cells over randomly selected high-power fields. Nuclear brown staining indicated positive expression when the percentage of cells stained was >10%, and negative when the percentage of cells stained was <10%. In this study, the positive p53-immunohistochemical staining was scored as moderate and strong nuclear immunoreactivity when in less than 50% and more than 50% of the tumor cells, respectively (Figure 1).

IBM SPSS Statistics 25.0 for Windows (IBM Corp., Armonk, NY, USA) was used to analyze the variables. Variables were given as the median (IQR), percentage, and frequency values. Categorical data were analyzed using the Fisher exact and the chi-square tests. In cases where the expected frequencies were less than 20%, the evaluation was made using the Monte Carlo simulation method to include these frequencies in the analysis. $P < 0.05$ and $P < 0.01$ were accepted as statistically significant.

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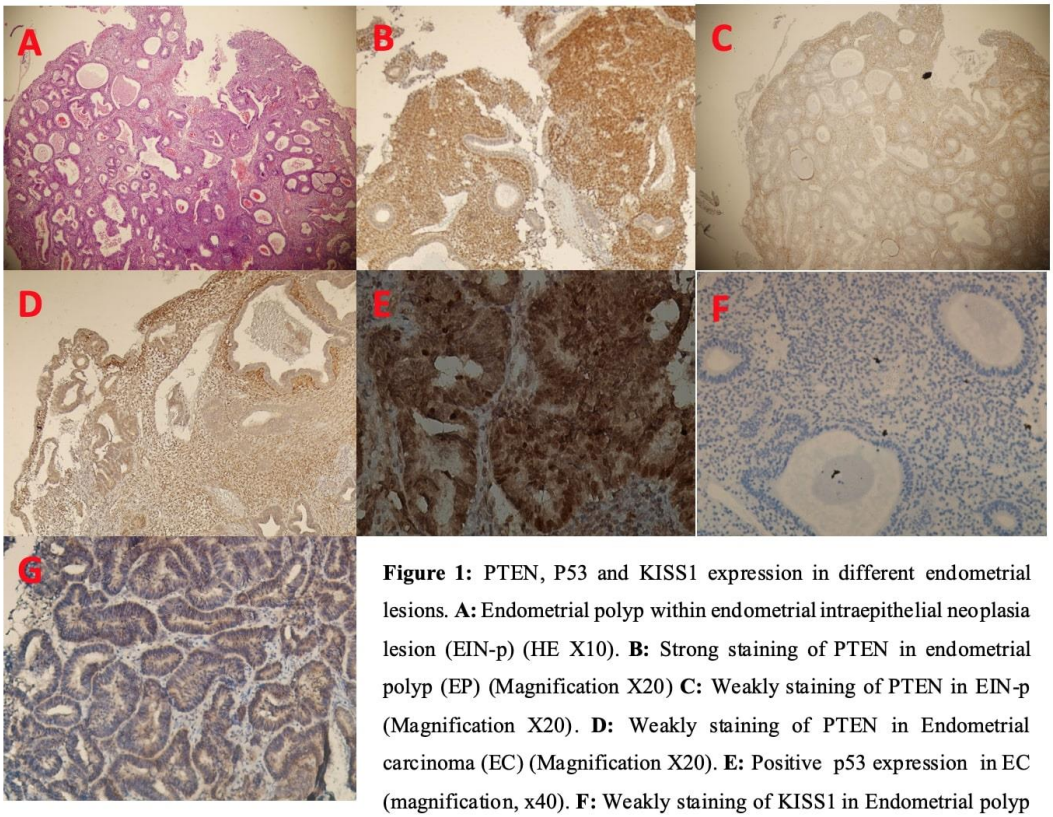

Figure 1: PTEN, P53 and KISS1 expression in different endometrial lesions. **A:** Endometrial polyp within endometrial intraepithelial neoplasia lesion (EIN-p) (HE X10). **B:** Strong staining of PTEN in endometrial polyp (EP) (Magnification X20) **C:** Weakly staining of PTEN in EIN-p (Magnification X20). **D:** Weakly staining of PTEN in Endometrial carcinoma (EC) (Magnification X20). **E:** Positive p53 expression in EC (magnification, x40). **F:** Weakly staining of KISS1 in Endometrial polyp (EP) (Magnification X40). **G:** Increased staining of KISS1 compare to normal endometrium.

Results

Among the patients included in the study, the mean age of the 90 patients in the benign endometrial lesions groups (NE, EP, and EH-p) was 46 years, while the mean age of the 62 patients in the EIN-p group was 52 years, and mean age of the 17 patients in the EC group was 54 years.

The comparison of the study groups according to immunostaining of p53, KISS1, and PTEN is presented in Table 1. In the benign groups, NE, EP, and EP-h, all of the samples showed negative staining with p53 and weak staining with KISS1, while in the EC and EIN-p groups, all of the samples showed moderate or strong staining with p53 and KISS1. By contrast, when staining with PTEN, no strong staining was observed in the EC or EIN-p groups, whereas all of the samples in the benign groups showed moderate or strong staining.

The negative, moderate, and strong staining rates for p53 in the EC group were 17.60%, 11.80%, and 70.60%, respectively, whereas in the EIN-p group, the rates were 24.20%, 37.10%, and 38.70%, respectively.

The weak, moderate, and strong staining rates for KISS1 immunosuppression were 29.40%, 11.80%, and 58.80%, respectively, in the EC group, whereas the rates were 1.60%, 43.50%, and 54.80%, respectively, in the EIN-p group. All of the samples in the NE, EP, and EP-h groups were negative for p53 staining, and they were weakly stained with KISS1.

Similarly, p53 and KISS1 showed stronger staining in the EC and EIN-p groups when compared with the other benign groups, and the EC group showed stronger staining than the EIN-p group. This difference was statistically significant ($P < 0.001$) (Table 2, Figures 2 and 3).

In terms of PTEN staining, no strong staining was observed in the EC or EIN-p groups, whereas 70.60% of the EC group showed weak staining, and 79.00% of the EIN-p group showed moderate staining. PTEN staining in the EC group was statistically significantly weaker when compared with the EIN-p group ($P < 0.001$). Weak staining with PTEN was never observed in the benign lesion groups, while 83.30% of the NE group and 80.00% of EP group showed strong staining, and 80.00% of EP-h group showed moderate staining, and this difference was statistically significant (Table 2, Figure 4).

When the EIN-p group was evaluated within itself, 8 of the 62 patients with hysterectomy were evaluated as having EC based on the pathology results. Of these malignant patients, 3 had myometrial invasion, 1 of which had a depth of >1/2 of the myometrium (Table 3). Of the 8 preparations of patients with malignancy, 7 were stained moderately or strongly with KISS1 and p53, and the preparation of 1 patient was negative for p53 and weakly stained with KISS1. However, this difference was not statistically significant ($P = 0.648$ for p53, $P = 0.023$ for KISS1).

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Table 1: Comparison of endometrial lesion groups according to immunostaining of p53, KISS1, and PTEN.

		EIN-p	EC	EP-h	EP	NE	Total	P-value
p53	**Negative**	15a (13.90%)	3a (2.80%)	30b (27.80%)	30b (27.80%)	30b (27.80%)	108 (100.00%)	0.001 Ω
	Moderate	23a (92.00%)	2b (8.00%)	0b (0.00%)	0b (0.00%)	0b (0.00%)	25 (100.00%)	
	Strong	24a (66.70%)	12b (33.30%)	0c (0.00%)	0c (0.00%)	0c (0.00%)	36 (100.00%)	
kiss	**Weak**	1a (1.00%)	5b (5.20%)	30c (31.30%)	30c (31.30%)	30c (31.30%)	96 (100.00%)	0.001 Ω
	Moderate	27a (93.10%)	2b (6.90%)	0b (0.00%)	0b (0.00%)	0b (0.00%)	29 (100.00%)	
	Strong	34a (77.30%)	10a (22.70%)	0b (0.00%)	0b (0.00%)	0b (0.00%)	44 (100.00%)	
pten	**Weak**	13a (52.00%)	12b (48.00%)	0c (0.00%)	0c (0.00%)	0c (0.00%)	25 (100.00%)	0.001 Ω
	Moderate	49a (53.80%)	5b (5.50%)	26a (28.60%)	6b (6.60%)	5b (5.50%)	91 (100.00%)	
	Strong	0a (0.00%)	0a. b (0.00%)	4b (7.50%)	24c (45.30%)	25c (47.20%)	53 (100.00%)	
Total		62 (36.70%)	17 (10.10%)	30 (17.80%)	30 (17.80%)	30 (17.80%)	169 (100.00%)	

Ω Monte Carlo Chi square method (exact). There is no statistically significant difference between the same letters (by Row). **EIN-p:** Endometrial intraepithelial neoplasia lesion within the endometrial polyp. **EC:** Endometroid carcinom. **EP-h:** Endometrial polyp with hyperplasia without atypia. **EP:** Endometrial polyp. **NE:** Normal (proliferative) endometrium

Table 2: Comparison of the degree of immunostaining of p53, KISS1, and PTEN in the endometrial lesions.

		p53			KISS1			PTEN			Total
		Negative	Moderate	Strong	Weak	Moderate	Strong	Weak	Moderate	Strong	
EIN -p	n (%)	15a (24.20%)	23b (37.10%)	24c (38.70%)	1a (1.60%)	27b (43.50%)	34b (54.80%)	13a (21.00%)	49a (79.00%)	0b (0.00%)	62 (100.00%)
EC	n (%)	3a (17.60%)	2a (11.80%)	12b (70.60%)	5a (29.40%)	2a. b (11.80%)	10b (58.80%)	12a (70.60%)	5b (29.40%)	0b (0.00%)	17 (100.00%)
EP-h	n (%)	30a (100.00%)	0b (0.00%)	0b (0.00%)	30a (100.00%)	0b (0.00%)	0b (0.00%)	0a (0.00%)	26b (86.70%)	4a (13.30%)	30 (100.00%)
EP	n (%)	30a (100.00%)	0b (0.00%)	0b (0.00%)	30a (100.00%)	0b (0.00%)	0b (0.00%)	0a (0.00%)	6a (20.00%)	24b (80.00%)	30 (100.00%)
NE	n (%)	30a (100.00%)	0b (0.00%)	0b (0.00%)	30a (100.00%)	0b (0.00%)	0b (0.00%)	0a (0.00%)	5a (16.70%)	25b (83.30%)	30 (100.00%)
p			0.001 Ω			0.001 Ω			0.001 Ω		

Table 3: Distribution of cases in the EIN-p group

		Total
Carsinoma (negative/positive)	n (%)	54 (87.10%) 5 (62.50%) 2 (66.70%)
Myometrial invasion (negative/positive)	n (%)	8 (12.90%) 3 (37.50%) 1 (33.30%)
Invasion depth (<1/2–>1/2)	n (%)	62 (100.00%) 8 (100.00%) 3 (100.00%)

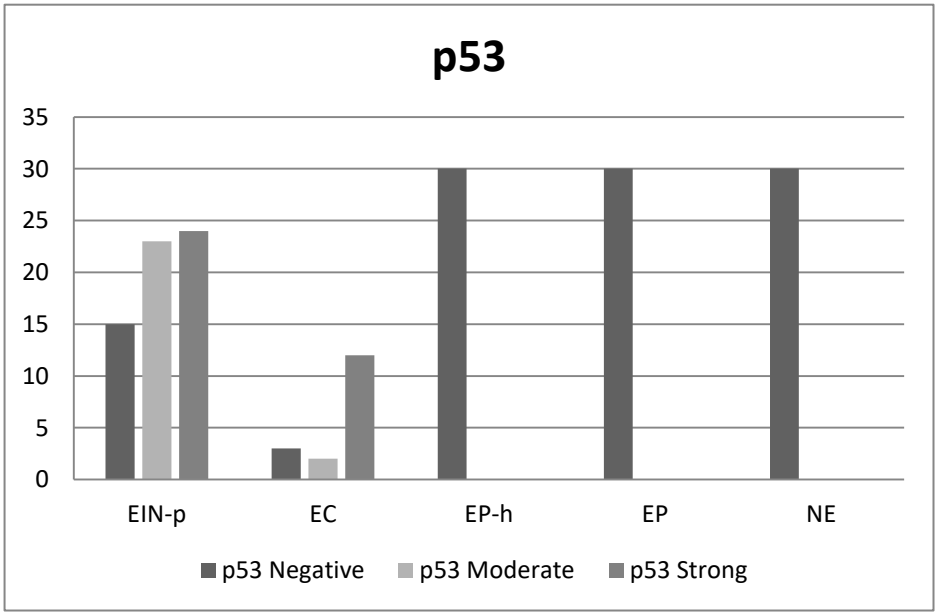

Figure2: immunstaining of p53 in different endometrial lesions.

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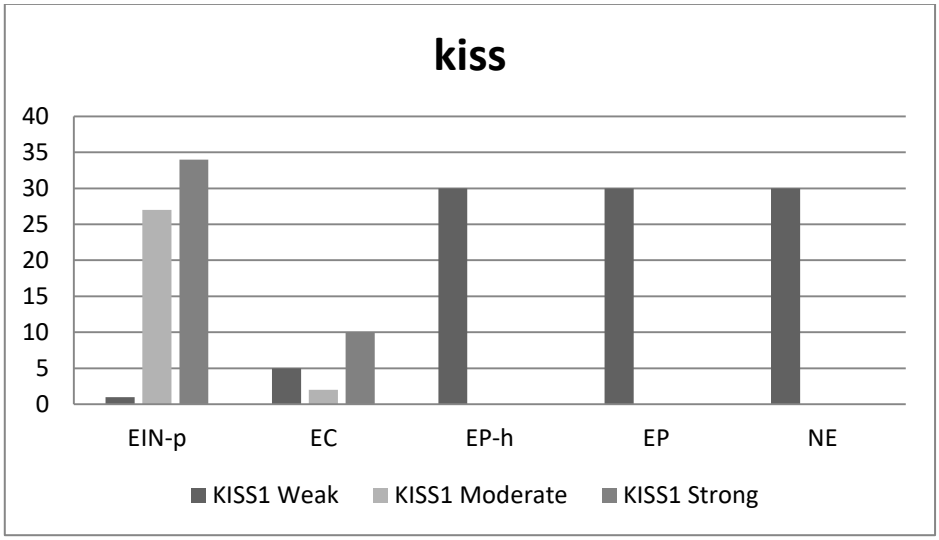

Figure 3: Immunstaining of KISS1 in different endometrial lesions.

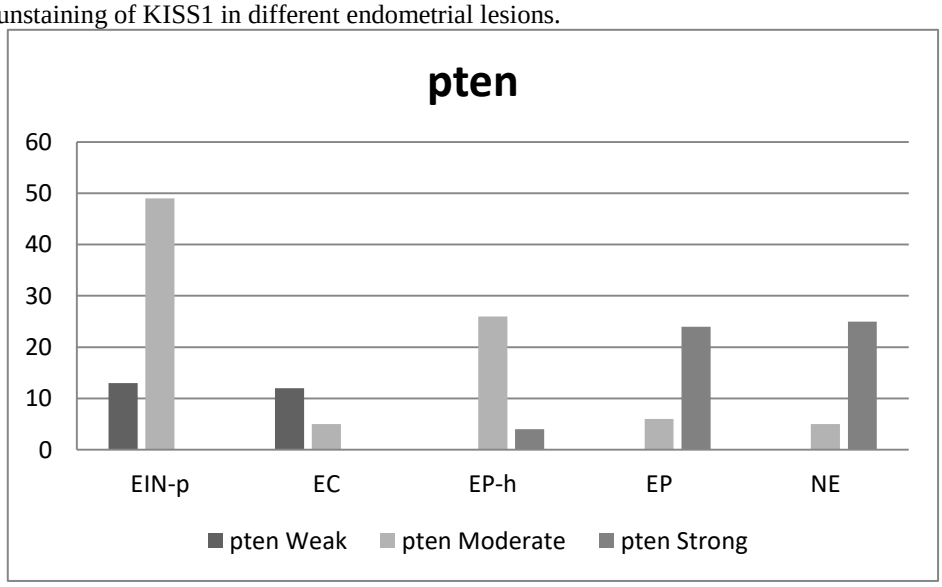

Figure 4: Immunstaining of PTEN in different endometrial lesions.

Discussion

In the current study, we aimed to evaluate the KISS1 in the malignant transformation of EIN-p using immunohistochemistry and compare the KISS1 expression to other tumor suppressor genes, P53 and PTEN, which have been the most studied. It was found that there was decreased PTEN expression in the premalignant and malignant endometrial lesions, while KISS1 expression was high. Expressions of p53 were wild-type. To the best of our knowledge, although there are many studies on p53 and PTEN, there are no studies on the evaluation of KISS1 in both premalignant and malignant endometrial lesions.

In 2016, it was suggested that PTEN immunohistochemistry could be used to distinguish premalignant and malignant lesions, especially among endometrial lesions, in a multidisciplinary panel with the participation of the European Society for Medical Oncology, the European Society for Radiotherapy and Oncology, and the European Society for Gynecological Oncology (17).

Although there is a consensus on the role of PTEN immunoexpression to differentiate endometrial benign tissues from malignant tissues, there is controversy on its role of in premalignant-malignant lesion discrimination.

Yang et al. (18) emphasized that PTEN immunexpression decreased significantly in ECs when compared with normal endometrial tissue. Adomaitiene et al. showed that there was a significant loss of PTEN expression in ECs, whereas malignant polyps (including polyps from patients in whom a polyp was found with coexisting endometrioid cancer or who had a focus of cancer inside) were reported as having high PTEN expression (19). In the current study, decreased PTEN expression in the EC and EIN-p groups was found when compared with the other lesion groups (EP-h, EP, and NE). In addition, weak staning was increased in the EC group when compared to the EIN-p group, which was premalignant. Among the benign groups, 80% of the patients in the EP-h group showed moderate staining with PTEN, and 80% of patients in the NE and EP groups showed strong staining with PTEN. Abrao et al. (7)

reported that PTEN expression decreased in polyps with EIN when compared with polyps without atypia, which was similar to the current results.

Studies have shown that the loss of PTEN and wild-type p53 (focal weak nuclear positivity) expression supported endometrioid carcinomas, while the retained expression of PTEN and aberrant expression of p53 (strong diffuse nuclear staining or completely absent staining), favored serous carcinomas (20,21). In the current study, it was found that p53 was negative in the NE, EP and EP-h groups. On the other hand, when the EC group was compared with the EIN-p group with p53 positivity, it was found that staining in the EC group was significantly stronger than that in the EIN-p group. However, Maia et al. showed that p53 was detected more frequently during the proliferative phase in endometrial polyps, similar to in normal endometria. Heterogeneous and weak expression of p53 in noncancerous endometria has been reported previously in cases of endometrial hyperplasia and metaplasia (22,23), and researchers believed that the presence of p53 expression may have been a consequence of elevations of wild-type p53 to correct DNA damage, and not the accumulation of the stable mutant form (24). Most of the mutation in TP53 increases the stabiliy of the protein, leading to an accumulation that is detectable by immunohistochemical staining. Hence, it was reported that the abnormal diffuse accumulation of p53 has been related to tumor cells and TP53 mutations most commonly seen in high-grade serous carcinomas. In the present study, 70% of the carcinoma patients showed nuclear staining of p53, but not with a diffuse pattern. In another study in which p53 mRNA real-time polymerase chain reaction and p53 protein immunohistochemistry were examined, the control, adenomyosis, polyp, and carcinoma groups were compared and increased p53 expression was reported as highest in the carcinoma group and lowest in the control group (25).

KISS1 expression rates have been reported very differently in different organ and tissue malignancies. Increased KISS1 expression has been reported in pancreatic and ovarian cancers, especially in the early stage, whereas it has been reported to be decreased in colorectal cancers (26,27). There are few studies on KISS1 expression in endometrial lesions. In a study comparing EC, EIN, and normal endometria, KISS1 mRNA expression was reported as 37.5%, 80%, and 83.3%, respectively (12). Similarly, Kang et al. showed that the prognosis of patients with ECs that were negative for KISS1 expression was significantly poorer than those that were positive for KISS1. They believed that a decreased expression of KISS1 was a poor prognostic factor and was relevant to both the invasive and metastatic capacity of endometrial cancers.

In the current study, weak staining with KISS1 was found in the NE, EP, and EP-h groups. The number of patients with strong or moderate staining was higher in the EC and EIN-p groups, whereas the number of patients with strong staining was higher in the EC group. However, little is known about how KISS1 expression is regulated in cancer cells. It is a matter of debate as to whether KISS1 expression is high from the very first moment or whether it increases in the form of a tumor suppressor gene to reduce invasion and improve prognosis and in premalignant tissues (14). In either case, strong KISS1 expression in the EIN-p and malignant tissues was found to aid in early diagnosis in this study. There is a need for further studies on larger numbers of patients with EIN-p who have had an invasive malignancy result after hysterectomy. In addition, studies on malignancies in different stages can provide information about the early or late expressions of KISS1.

This study had some limitations that including the low number of patients. The malignancy rate was 12% in the EIN-p group. Of the 62 patients diagnosed after probe curettage, 8 were diagnosed as having carcinomas after hysterectomy. PTEN, KISS1, and p53 expressions of the patients in this group were compared. There was no difference in terms of the PTEN expression between the 8 patients who were diagnosed as having EC and the 54 other patients. Although the p53 and KISS1 expressions were stronger in the patients with EC, the difference was not statistically significant. It was thought that this was due to the low number of patients, because some of the patients who were diagnosed as having EIN-p after probe curettage may have undergone treatments other than hysterectomy or patients may have gone for the follow-ups at other clinics for treatment. Despite this limitation, the strength of this study is that it is one of the rare studies on EIN-p among endometrial lesions, and it is the first study on KISS1 expression.

In conclusion, according to the data herein, it was speculated that KISS1 may play an important role in the malignant transformations of endometrial polyps and it might be used as a predicting marker in this patient group.

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Conflict of interest: No actual or potential conflicts of interest exist in relation to this article.

Ethical approval: This study was approved by the local ethics committee of Başkent University (register number KA19/257). All of the participants gave written informed consent prior to participation.

Ethical issues: All authors declare originality and ethical approval of research. Responsibilities of research, responsibilities against local ethics commission are under the authors responsibilities. The study was conducted under defined rules by the local ethics commission guidelines and audits.

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Wear of ceramics systems with different surface applications in a chewing simulator

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Abstract

Objective: This study was aimed to compare the wear of four types of the ceramic dental materials with different surface treatments.

Material and Methods: Porcelain (low-fusing feldspathic, monolithic zirconia, lithium disilicate glass, and leucite glass-ceramic) samples (9 x 3 mm) were prepared with different surface treatments (glazed and mechanical polished). Samples were mechanically loaded in a chewing simulator (600.000 cyles of 50N) and 64 teeth were used to simulate as the antagonist. To evaluate the wear of the samples before and after the test, samples were scanned by 3D scanner, Dental Wings 7 Series. Then they were transformed into the digital platform. Surface analysis was performed by using an optical profilometer and scanning electron microscope. A sensitive digital scale was used for weight measurements of antagonist's teeth.

Results: It was a significant difference between the volume values of the groups with mechanical polish and the groups with glaze, except for zirconia samples ($p<0.05$). While the least change in volume and surface roughness was observed in the zirconia mechanic polished group (ZP), this change was not statistically significant ($p>0.05$). In terms of the weight measurement results of the antagonist teeth, while leucite reinforced overglazed group (PRG) has the highest weight loss as a result of wear, ZP group has the least weight loss.

Conclusion: It was concluded that glazed groups of ceramics lose more substances than polished groups, and that causes more wear on antagonist teeth. Zirconia ceramics showed less substance loss, and that causes less wear on antagonist teeth.

Keywords: Dental Ceramic Systems, Chewing Simulator, Surface roughness, polished and glazed surface, SEM.

Introduction

Dentistry focuses on oral function and material longevity as well as aesthetics. Therefore, the dentists have been searching for ideal restorative materials for more than a hundred years. Low light transmittance and the possible gingival coloration are the first negative aspects of metal-ceramic systems (1). With the development of technology and the tendency of the patients to naturalness, full ceramic restorations have gained importance in dentistry.

The marginal edge compatibility of these ceramics, their biological compatibility with tissues, color stability, chemical and wear resistance are the characteristics which make them attractive. However, these ceramics are fragile and have limited tensile strength. Many efforts have been made to eliminate these negative aspects and provide the desired aesthetics (2, 3, 4, 5).

The glaze is applied during the application of dental porcelain, for the purpose of increasing of the aesthetic characteristics, such as, gaining natural tooth appearance, reducing plaque retention, and making cleaning easy (6, 7). However, it is known that in most of the pre- or post-cementation processes, the glazed layer is removed by occlusal adaptations (8). In addition, in clinical studies, it has been reported that in the mouth the glazed layer is removed from dental porcelain in a period of six months (9).

Dental porcelain after the application of the shield glaze layer exhibits more rough and aesthetically reduced appearance. An increased surface roughness has been reported to have negative effects on restorative materials in terms of staining (10).

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Bollen et al., (11) reported that the restorations with an average surface roughness of more than 0.2 µm increase wear as well as the deposit of plaques. According to the data in the literature, restorations have also been described as being more abrasive as the surface roughness increases (12, 13).

The aim of this study is to investigate the abrasion and surface roughness variations as a result of the exposure of various specimen groups with dental porcelain systems with different contents, such as Feldspathic (Super Porcelain EX-3, Kuraray Noritake Dental Inc., Japan), zirconia (Katana Zirconia UTML, Kuraray Noritake Dental Inc.,Japan), leucite-reinforced (IPS empress CAD, IvoclarVivadent, Liechtenstein), lithium disilicate-reinforced (IPS e.max CAD, IvoclarVivadent, Liechtenstein) to a chewing simulator after glazing and polishing.

Material and method

In the study, which investigates the wear behavior of various dental porcelain systems used today, four dissimilar dental porcelain systems as Feldspathic, monolithic zirconia, leucite-reinforced, lithium disilicate-reinforced are determined for the investigation (Table 1).

It is decided to divide the groups with dental porcelains into two within their own group (n=8), and to apply various surface treatments for glazing and mechanical polishing to each subgroup. The porcelain specimen groups have reached to total 64. By the chewing simulation used, the antagonist of each specimen with dental porcelain, 64 premolar which were removed due to orthodontic and periodontal indications, were not lost due to mechanical and chemical reasons and without caries and fillings, were collected. Before the treatment of the enamel surface of the dental specimens, the residues on top of the dental specimens were cleaned by polishing at low speeds and the teeth were kept in 0.1% thymol solution until the day of the experiment in order to prevent degradation of the tooth tissue.

Preparation of Porcelain Specimens

Dental porcelains were standardized as circle-based cylinders in 9 mm diameter and 3 mm height. The size control of all specimens was provided by an electronic caliper with a precision of 0.01 mm.

Preparation of Feldspathic Porcelain Specimens

By a conventional method (hand work), porcelain EX-3 low heat feldspathic system (Kuraray Noritake Dental Inc., Miyoshi, Japan) was prepared. As the manufacturer indicated, considering that the material size would change during firing, the specimen was poured into PEEK (Polyether ether ketone) molds designed as 10% larger dimensions than the desired 9 x 3 mm dimensions. Feldspathic porcelains which were prepared by handwork, as indicated by the manufacturer, dried at 600˚C for 7 minutes. Then the vacuum process was started and finished at 920˚C. The entire firing procedure was terminated at a temperature increase of 45˚C per minute at 930˚C. Of the 16 specimens prepared, glazing was applied to 8 specimens and mechanical polish was applied to the other 8. Firing and glazing operations were performed in Ivoclar Vivadent Programat EP 3000 (IvoclarVivadent, Schaan, Liechtenstein).

Preparing Monolithic Zirconia-Ceramics

Monolithic Zirconia CAD/CAM system was prepared in Katana Zirconia UTML (Kuraray noritake dental Inc., Miyoshi, Japan) Yenamak CAD/CAM. Zirconia discs engraved in CAD/CAM system were subjected to the sintering process in accordance with the directive given by the manufacturer. Sintering was applied at a 10˚C per minute heating rate up to a furnace temperature of 1550'C for 2 hours, and the temperature of the furnace was cooled by 10˚C per minute to the room temperature. Of the 16 zirconia specimens prepared, glazing was randomly applied to 8 specimens and mechanical polish was applied to the other 8.

Table 1. Ceramic used in the study

Ceramics	Manufacturer	Lot No	Surface Application	Code
Super porcelain EX-3 (felsdpathic porcelain)	Kuraray noritake dental Inc. Japan	DUYLM	Overglazing Mechanic Polishing	SPG SPP
Katana zirconia UTML	Kuraray noritake dental Inc. Japan	DQUGJ	Overglazing Mechanic Polishing	ZG ZP
IPS e.max CAD (lithium disilicate reinforced porcelain)	Ivoclar Vivadent, Liechtenstein	X50772	Overglazing Mechanic Polishing	MXG MXP
IPS empress CAD (leucite reinforced porcelain)	Ivoclar Vivadent, Liechtenstein	U22412	Overglazing Mechanic Polishing	PRG PRP

Table 2. The glazed procedure of porcelain samples according to the manufacturer's instructions

	CT (min)	HR (˚C)	V_1 (˚C)	V_2 (˚C)
Low Fusing Porcelain	5	50 ˚	650 ˚	910 ˚
Monolithic Zirconia	5	65	600 ˚	
Lithium Disilicate Ceramic	6	60˚	450 ˚	724˚
Leucite Reinforced Ceramic	6	100 ˚	450 ˚	789 ˚

CT: Closing time HR:Heating Fire V: Vacuum

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Preparing Lithium Disilicate Glass-Ceramics

In the system of CAD/CAM, prepared lithium disilicate glass porcelain discs were fired according to the instructions of the manufacturer. The first firing operation was held increasing the heat by 90˚Cper minute up to 820˚C after a process of drying at 403˚C for six minutes. During the first firing process, the first vacuuming operation was held between 550˚C and 820˚C. After waiting for 10 seconds at 820˚C, the second firing operation got started. During the operation, the heat got increased by 30˚C per minute up to 840˚C. During the operation the vacuuming operation kept continued. After the specimens were kept stable at 840˚C for 7 minutes, to cool down for a long time. Of the 16 specimens prepared, 8 of them were separated for glazing and 8 for mechanical polishing.

Preparing Leucit Glass-Ceramics

Leucit glass-ceramic was prepared by CAD/CAM system. Of the 16 specimens prepared, glazing was applied to the 8 of them and mechanic polishing was applied to the other 8 ones.

Glazing Procedure of The Samples

Firing and glazing operations were performed in Ivoclar Vivadent Programat EP 3000 (IvoclarVivadent, Schaan, Liechtenstein) for all porcelain samples (Table 2).

Extraoral Mechanical Polishing of The Samples

The same polishing process was applied extra orally to the porcelain samples reserved for mechanical polish. First of all the samples were cleaned ultrasonically. All the surfaces were prepared by using first abrasive paper and then polished with using white then blue disc (Reddish Stone, Italia) a diamond paste with 40 µm particles (Zirkopol; Feguramed, Germany) for 60 seconds each surface.

Porcelain specimens used in this study were examined before and after the experiment and their volume values were recorded. Pre and post-treatment weight values of dental specimens used as antagonists of porcelain specimens were recorded.

In order to evaluate the wear of the porcelain specimens before and after the test, specimens were scanned by 3D scanner, Dental Wings 7 Series (Dental Wings, Montreal, Canada) and in order to examine they were transformed into the digital platform Geomagic Control X (3D Systems, Rock Hill, USA). Their volume data were obtained through this program. The weights of dental antagonists were measured at the assay balance, A&D Weighing GR-300 lab balance (A&D Instruments Limited, United Kingdom).

Chewing Simulation Test

Occlusal simulation operation for porcelain specimens which were used in the study was implemented by SD Mechatronik Chewing Simulator CS-4.8 biaxial fatigue testing (SD Mechatronik GMBH, MiesbacherStraße 34 D-83620 Feldkirchen-Westerham, Germany).

For simulation, porcelains were placed into the clips by burying them in (9mm x 3mm) acrylic resin, the dental antagonists were also placed into the clips by burying them in (9mm x 7mm) acryl. The specimens and teeth were put in the simulation tool kit and it was calibrated (Fig. 1).

Surface Roughness Test

In order to examine the pre- and post-trial 3D values of surface roughness of porcelain specimens, an Optical Profilometer (Phaze View/Zee Scope, France) was used. For the analysis, GetPhase software was used. The analysis of the surface roughness for each specimen was performed at an area of 1 mm2 and for 1 analysis by shifting 25 µm, 40 images were taken and overlapped. Surfaces of each glazed and mechanically polished random samples of porcelain groups were analyzed via scanning electron microscope (FEG-SEM, Mira 3 XMU, Brno, CZ).

As the data obtained in this study by loading into SPSS (Ver.22.0) parametrical test hypothesis were applied for the evaluation, in (Kolmogorof-Simirnov) independent groups, the Probability Test between two means, Variance Analysis, Tukey Test, and the Test of Significance for the difference of means were used and the deviation was taken as 0,05.

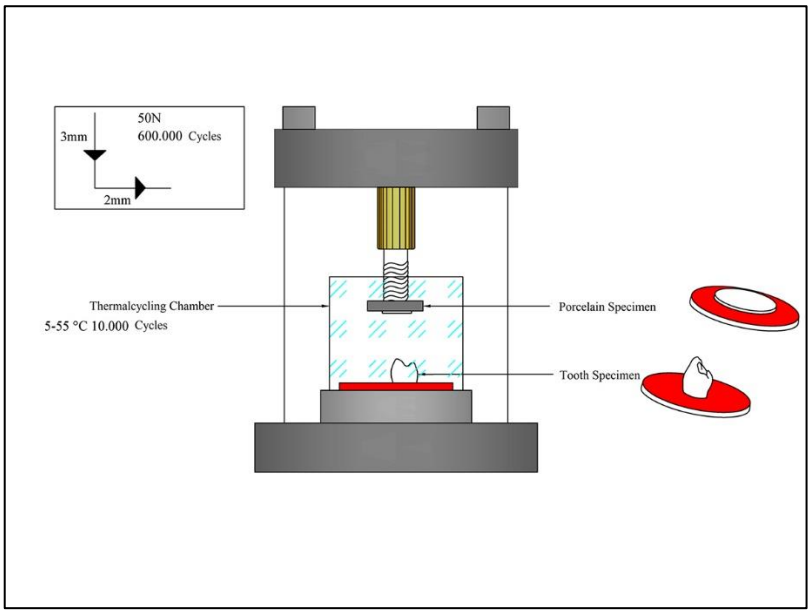

Figure 1. Schematic view of the chewing simulation device

Results

In the study, the baseline values obtained from porcelain and the volume values obtained after wear have been presented in Table 3 and the weight values of antagonist's teeth are presented in Table 4.

Of porcelain specimens exposed to wear on their surfaces by chewing simulation, the groups applied overglazing are found to have the highest volumetric change results in PRG group, and the least volumetric change results in ZG group. When the groups which were applied mechanical polishing compared to each other, it is determined that we have results that are similar to the groups applied glazing.

Within the binary comparison of the same porcelain groups which were applied glazing and the groups which were applied mechanical surface polishing, it is observed that there are statistically differences except for the zirconia porcelain group ($p \leqslant 0.05$). Within all porcelain systems which were applied mechanical polishing and glazing, it is determined that the groups which applied glazing have higher ceramic volume change than mechanical polished groups have (Table 3, Figs. 2,3). As a result of the examination of data concerning wear on all samples, it is observed that while the most worn sample group is PRG, the least worn ones are within the ZP samples (Figs. 2,3).

Table 3. Volume (mm3) values obtained after chewing simulation and baseline of porcelain samples used in the study (Mean ± SD)

	Baseline Mean±SD	After Process Mean±SD	p
SPG	190.3788±0.14990	187.0975±0.14762	0.001*
SPP	190.5875±0.24933	189.0250±0.24871	0.001*
ZG	190.6400±0.29052	190.2950±0.29617	0.001*
ZP	190.4838±0.32772	190.3738±0.32601	0.001*
PRG	190.5863±0.23360	180.7663±0.25304	0.001*
PRP	190.4025±0.18227	183.5787±0.26199	0.001*
MXG	190.6325±0.17310	183.5550±0.20466	0.001*
MXP	190.7613±0.10077	188.4563±0.07110	0.001*

*p<0,05

Table 4. The average weight of antagonist teeth against ceramics specimens (Mean ± SD) (g)

	Baseline Mean±SD	After Process Mean±SD	p
SPG	1.0725±0.01035	0.9850±0.01604	0,001*
SPP	1.0663±0.01061	0.9963±0.01685	0,001*
ZG	1.0763±0.01061	1.0175±0.01282	0,001*
ZP	1.0675±0.01832	1.0313±0.01727	0,001*
PRG	1.0588±0.01458	0.8925±0.01581	0,001*
PRP	1.0663±0.01685	0.9612±0.01458	0,001*
MXG	1.0638±0.01061	0.9500±0.01604	0,001*
MXP	1.0612±0.01553	0.9813±0.01642	0,001*

*p<0,05

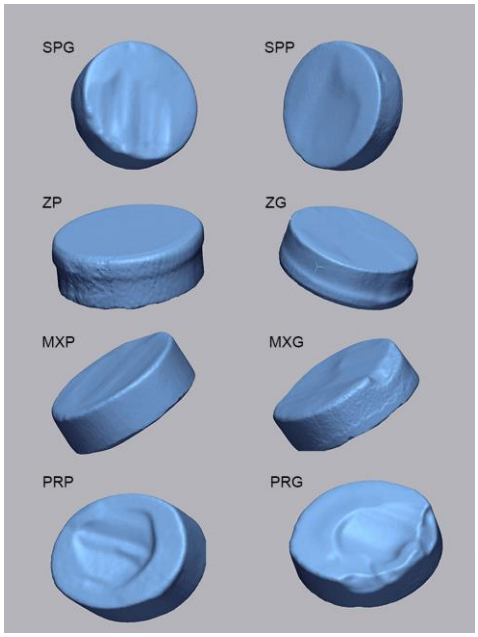

Figure 2. Post-wear 3D images of ceramic sample groups

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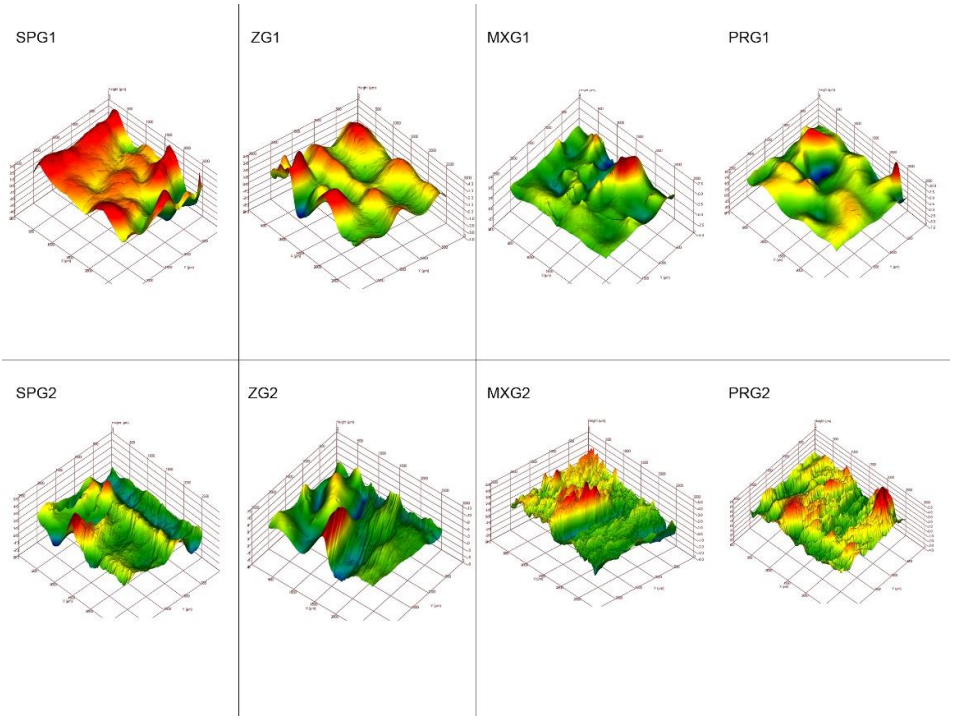

Figure 3. Optical profilometer images of glaze applied ceramic sample groups (1) baseline, (2) after abrasion in the chewing simulation device

Table 5. Ra (nm) (Mean ± SD) values of ceramic samples used in the study.

	Baseline Mean±SD	After Process Mean±SD	p
SPG	95.275±0.5092	131.750±0.5043	0,001*
SPP	99.513±0.1727	104.113±0.1642	0,001*
ZG	97.713±0.7298	202.388±0.7772	0,001*
ZP	99.288±0.3682	104.025±0.3454	0,001*
PRG	91.525±0.4833	304.888±4.0551	0,001*
PRP	96.088±0.8610	221.863±0.4173	0,001*
MXG	96.400±0.1309	308.338±1.3244	0,001*
MXP	90.613±0.0835	150.938±0.4689	0,001*

*p<0,05

The statistical results of the weight changes of the dental specimens which we used as antagonists of porcelain samples in the study are given in Table 4. When the weight measurements have been compared to each other after the operation, both the groups which were applied glazing and the groups which were applied mechanical polishing within their own subgroups, the difference is found statistically significant (p<0,05).

Among the groups which were applied glazing, it is observed that while the loss of dental weight is the least in ZG group, it is the highest in PRG. Among the groups which were applied mechanical polishing, while it is observed that the loss of dental weight for antagonist teeth is the least in ZP group, it is the highest in PRP. When the dental weights belonging to the same porcelain groups are binary compared, whereas the difference in the samples including leucite is statistically significant (p<0,05), the difference is observed not to be significant in other groups (p>0.05).

In this study, the baseline obtained from pre-wear process of the porcelain systems, the surface roughness (Ra) values obtained from the samples of porcelain systems in the post-wear process and their standard deviation values have been given in Table 5. When this table is analyzed, it is observed that the difference between the surface roughness (Ra) values obtained after the baseline and abrasion processes is the highest in PRG group and it is the least in ZP group. When the (Ra) values were analyzed belonging to data, after glazing and mechanical polishing applications, it is remarkable that the (Ra) values of baseline are below 100 nm in all specimen groups. Besides it is observed that the (Ra) values obtained after the wear process by chewing simulator had relatively increased more in the groups applied glazing than in the groups which applied mechanical polishing (Table 5, Fig. 4).

SEM Results

Figure 5 represents the SEM topographical electron images of all samples. As seen from SEM images, abrasion was observed in all sample groups.

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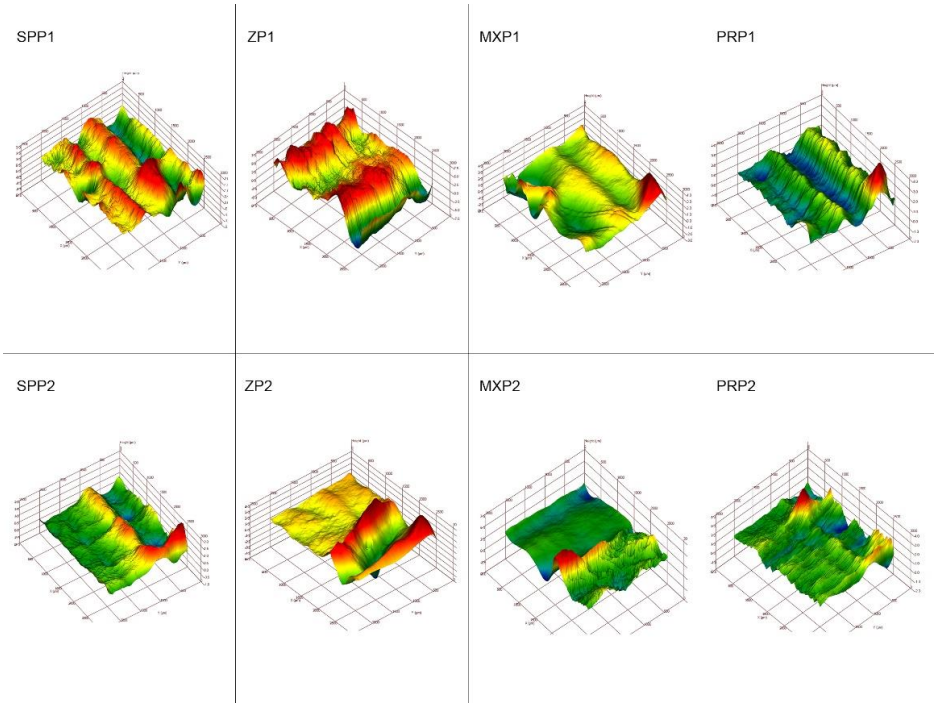

Figure 4. Optical profilometer images of porcelain specimens with mechanical polishing (1) baseline, (2) after wear in the chewing simulator

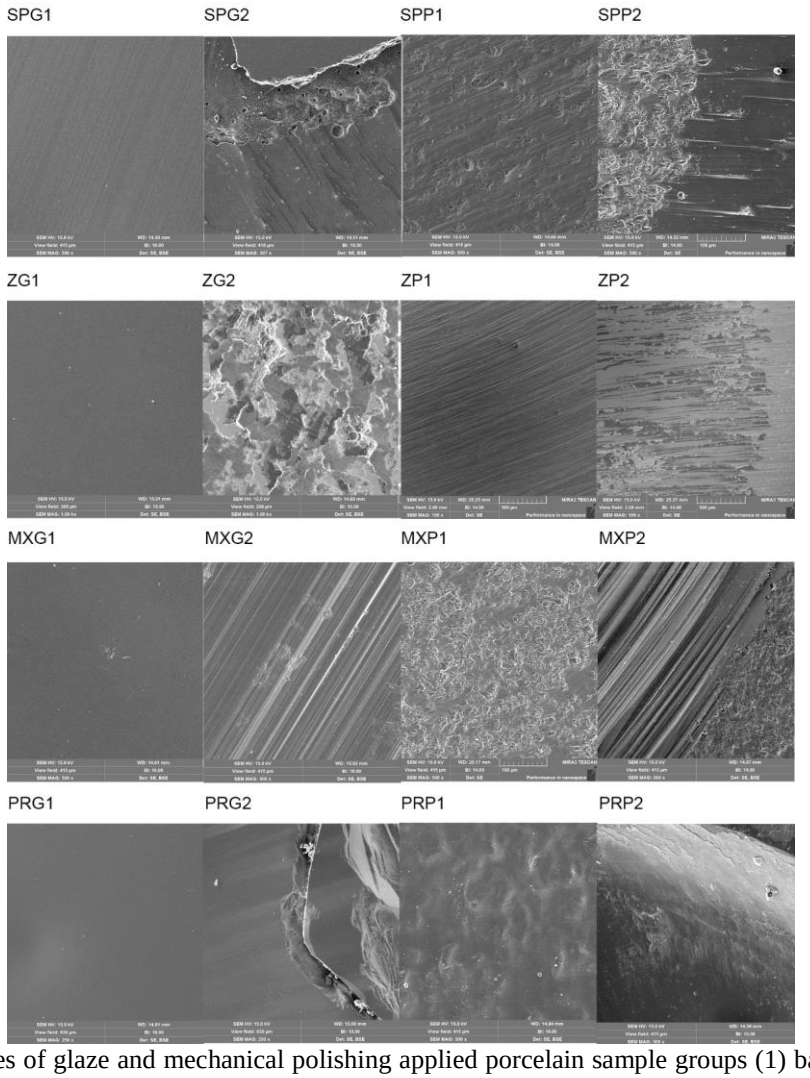

Figure 5. SEM images of glaze and mechanical polishing applied porcelain sample groups (1) baseline, (2) after wear in the chewing simulator

For SEM pictures of SPG1 and SPG2, the initial surface seems to be smooth but after the operation, the wear track is seen in the form of delamination and compression and scratches from the upper left to lower right region. The grooves are visible and the inner porosity is seen due to delamination after compression whose compression strength is low and fracture toughness is among the lowest as around 1 MPa. √ m. The scratches are seen parallel to the fractured area and left the surface from edges.

For SPP1 and SPP2, the surface is polymerized accordingly and has surface pores due to the high amount of polymer composite. Polymer surface was adhesively deformed and worn by the contact of antagonist tooth. The easier wear loss was seen due to damage of the polymer interface, on the polymer loss, there can be seen some scratches which continues to deform the polymer to increase the wear loss.

In SEM pictures of ZG1 and ZG2, prior to test, the surface is seen very smooth and low Ra is observed. During the test time, the brittle ceramic-like fracture morphology is seen on the polymer adhesive wear surface. The lost regions are of ceramics with brittle structure as well as cross-linked polymers. The whiter the fractured regions, the higher the ceramic content is observable and blackish regions are binding polymers, cross-linked.

In ZP1 and ZP2, the surface is parallel smooth by mechanical polishing, but the worn surface is seen in grooves. The compression and adhesive structure is seen. The lowest Ra change and wear loss may indicate the low amount of material removal. The whiter regions are still the ceramic phase and black and grey ones are of polymer or filler type.

MXG1 and MXG2 are seen smooth prior to tests. But after tests, a total areal removal is seen by produced grooves with deep valleys. The deformed areas are also under compression and regional material loss is seen. MXP1 and MXP2 are looked like as SPP1 and SPP2, respectively. The polymerized surface is seen and the polymer removal after test is observable. The parallel grooves are very deep and high material is therefore seen.

PRG1 is also very smooth before test and the brittle and sudden fracture is seen after the test. Within the fracture, a high wear loss can be seen and on the worn surface, there are some more scratches that indicate that during the test, the material resisted fracturing but the fracture strength was exceeded by the load of antagonist tooth.

PRP1 and PRP2 have pore free surface with an average roughness value and the surface is only compressed without any significant groove but high deformation. This deformation may lead to wear loss in a certain amount. Some surficial pores are seen due to contact of antagonist and deformation regions.

Discussion

The physical factors that are exposed to teeth and dental restorations are often seen as mechanical wear. What is expected from dental restorations is that they resist to mechanical and physical wear in the oral cavity and have fewer wear characteristics against the counter tissues. In terms of classification, mechanical wear is named as the atrium formed by two-body interaction (2-body) and wear as a result of three-body interaction (3-body). These two types of mechanical wear continuously occur in the mouth (14).

Chewing simulators are used to reflect the oral environment to the laboratory environment (14, 15). In the study, in order to optimally simulate the in vivo environment, we have implemented 600.000 chewing simulations in 1 Hz frequency by applying 50N force, with a 2 mm horizontal and 3 mm vertical move. In parallel with this process, 10.000 thermal cycles have been applied to the materials at 5-55 ° C in order to expose the materials to wear which is similar to the environment in the mouth. This simulation thus simulates an oral environment of approximately 2.5 years (15, 16).

In this study, in order to obtain a real-like simulation, natural teeth that were not lost due to chemical and physical factors, the teeth without caries and fillings, and the teeth which were not newly extracted for orthodontic and periodontal reasons, were used. In the light of previous studies, the extracted teeth were waited in % 0.1 thymol solution after cleaning plaques on them (17, 18).

During the chewing simulation process of this study, for the contact standardization, among the teeth showing cusp-like morphological structures, only buccal cusps are provided to contact with the teeth (14). Although there are many literature studies on wear and material losses, measurements of wear value have been performed differently (19, 12, 14, 20, 13, 17, 18). Some researchers measure the wear values according to changes in height of materials and the depth of lost area (21, 22). However, such measurements assume that the wear area is a homogeneous structure and does not care much about the morphological structure. In the literature, it is stated that the wear and material loss are also calculated according to the mass change in the materials (19, 23). However, the disadvantages of weight measurements are that the moisture content in the tooth tissue is not under definite control and this may adversely affect the measurements (18). In the study, the wear values of porcelain samples have been determined according to the volumetric changes and the calculations of the weight measurements of the wear belonging to the teeth used as the antagonist.

In a study, it is reported that the lithium disilicate-containing ceramics are the most abrasive than the leucite-containing porcelains, and there is no significant difference between zirconia and stainless steel crowns in terms of wear of their antagonists (18). In addition that in the same study, it is stated that among the restorative materials, in terms of their own wear, the lithium disilicate-containing porcelains are the groups with the highest material loss and zirconia and stainless steel crowns are the groups with the least material loss(18).

In another study, zirconia specimens are reported to signify less wear than feldsphatic and lithium disilicate specimens (24). In the study examining the wear on enamel tissues of feldsphatic and leucite-containing ceramics which have various pH values, it is reported that the porcelain

specimens which have high pungency levels cause less wear on the antagonist teeth than the porcelain specimens which have low pungency levels do (25). In parallel with the findings of the studies above, we have observed that zirconia porcelains with almost twice pungency value cause less wear on their antagonists than the groups with feldsphatic, leucite, and disilicate-containing.

In a study in which the effects of glazing and mechanical polishing operations applied to the zirconia porcelains on antagonist teeth have been examined, glazed porcelains are reported to specify high wear and erosion characteristics (17). The results of this study indicate that the groups which were applied glazing and mechanical polishing of zirconia porcelains do not have significant differences in terms of wear and erosion. Except for the zirconia porcelain groups used in the study, all glazed groups are observed to lose more material and to abrade their antagonist teeth more. On the other hand, a study that is similar to ours, it is reported that feldsphatic porcelains with mechanical polishing abrade less teeth tissue than glazed specimens do (26).

There is enough energy to provide continuous t-m phase transitions in the zirconia structure. This conversion, manifested by volume increase, creates compressive stresses around cracks in the structure and prevents crack propagation, and increases the mechanical strength of the material. This mechanism, in the literature, is called 'Transformation Toughening'. The transformation mechanism of zirconia which is not present in other dental ceramics increases the mechanical properties of zirconia to a high degree (27, 28). We could identify that as zirconia has the conversion toughness characteristic, there are fewer differences on the surfaces of zirconia specimens and they cause the least wear on antagonist teeth.

It is stated that materials with low fracture toughness are more easily broken and rough surfaces are formed, and broken glass particles enter the environment as a third abrasive body, and as a result all these increase the wear effect (29, 30). In this study, within various porcelain systems, among the porcelain specimens applied glazing and mechanic polishing, the highest wear loss was seen in leucite containing porcelain systems (Table 2). We can relate this to the fracture toughness of materials. Because the bending strength of leucite-including porcelains is low as 120-160 MPa, and their fracture toughness is about 1.3 MPa.m1/2, which are lower than both zirconia and lithium-disicilate porcelain systems. However, in the current study, although the bending strength of feldsphatic porcelains both in the groups applied glazing and the groups applied mechanical polishing is (60-70MPa) and their fracture strength is (0,92-1,26 MPa.m½), it was seen that they caused less wear and less erosion on the antagonist teeth than leucite and lithium-disilicate porcelain specimens did due to the lowest surface roughness and smoothness. This is also incompatible with other studies in the literature (24, 31). It can be said that this discrepancy may be related to the structural and morphological variations of the teeth used as antagonists during the operation and it also occurs due to the differences in our experimental conditions.

In the analysis of wear and erosion characteristics of dental porcelains, it will be wrong to solely analyze the toughness of the materials and their fracture toughness, besides that it shouldn't be forgotten that the surface roughness is also a major factor. It is explained that as long as the surface roughness of restorations increases, they become more abrasive (13). In addition that, it is reported that the increase of surface roughness causes an increase in the area of the materials and a decrease in surface energy, therefore it can cause an increase in bacteria and plaque retention (11, 32, 33, 34).

Kohles et. al. (2004)(39) reports that the measurement method of the devices used for the surface operations significantly affects the data of roughness. On the measurements of the surface topography, there are mechanic profilometer devices and optical profilometer devices which provide qualitative data as electron microscopes do and there are devices which provide quantitative data as atomic force microscopes (35).

It was reported that during the operations the metal ends and the contact surface mechanical profilometer may be damaged and thus this affects the accuracy of the measurement (36). Accordingly, we have performed measurements using an optical profilometer (Phase View ZeeScope France) tester for surface roughness tests.

In a study, the wear characteristics of various composite materials (zirconia, lithium-disilicate ceramic, composite resin) were examined in comparison to the antagonist of natural teeth after a simulation of 4800 cycles. After the operation, it was found that the increase of surface roughness (Ra) of all materials was statistically different (37). In another study in which various porcelains exposed to 240.000 chewing cycles under 50N force, it has been reported that in comparison with the antagonist teeth, there are significant differences between feldsphatic porcelains which were applied mechanical polishing and zirconia specimens, and that more surface roughness in feldspathic specimens occur and this causes more abrasion on teeth (38). In another study, after dividing zirconia, feldsphatic and lithium-disilicate porcelains into groups as rough, glazed, and polished, their abrasions are examined in comparison to the tooth and it is reported that the groups with glazing perform more wear than the other groups (31).

The findings of the study show that the composites of the materials may affect the degree of wear of the material and the level of erosion of the opposing tissues. It is seen that leucite-containing porcelains have the highest wear on themselves and on their antagonist tooth tissue among the groups applied glazing and mechanical polishing (Figs.3, 4). The leucite group is followed by porcelain systems containing lithium-disilicate. As formerly mentioned, we can relate this condition to fracture strength and hardness rather than the toughness of the materials.

Conclusion

It is not forgotten that the glaze layer of the dental porcelains is removed both in the natural oral environment, by occlusal non-compliance, and by the duration of their use, and that the removed layers become rough and they

will cause more abrasion and erosion. In this case, the dentist, in the control sessions, by performing mechanical polishing within the mouth, could increase both mechanical and aesthetic properties.

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