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Comparing The Pull Out Resistance Of Two Typs Of Posts Used In restoration of severely damaged primary anterior teeth (A Comparative In Vitro Study.)

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Abstract :

Background: severely damaged primary anterior teeth that require pulp therapy present a high-risk of failure due to the loss of tooth substance resulting from pre-existing decay and endodontic therapy itself. The ideal post material should have physical and mechanical properties that are similar to those of dentin . Another concern in restoring endodontically treated primary teeth is the need to find a material that can resorb in a similar way to natural tooth structure as a part of the exfoliation process allowing normal eruption of permanent successors . Accordingly there is no such material other than dentine itself.The introduction of Biological dentine posts offered an excellent alternative for restoring such teeth .The aim of the current study was to assess the effect of using dentine posts on the Pull Out resistance of endodontically treated primary anterior teeth in comparison to composite posts.

Materials and methods: A sample of 30 primary anterior teeth was collected from the outpatient clinic of Pediatric Dentistry Department, Faculty of Dentistry,Damascus University. 15 freshly extracted permanent teeth with single root were also collected from the outpatient clinic of Maxillofacial Surgery Department, Faculty of Dentistry,Damascus. University. The roots of the permanent teeth were used to prepare 30 dentine posts using CAD-CAM machine. After receiving proper endodontic treatment, the primary teeth were divided into two groups (15 teeth in each group). The first group was restored with dentine posts, and the second group was restored with composite posts 3 mm in length for both groups. Pull Out resistance testing was performed using Testometric machine.

Results: The results were recorded.descriptive statistics were performed and the data were analyzed at 95% confidence interval using independent t-student test. There were no statistically significant differences in Pull Out resistance between the two groups. But Dentin posts showed increased in Pull Out resistance (156,7) N more than composite posts (149,7) N.

Conclusion: Dentin posts showed increased in Pull Out resistance (156,7) N more than composite posts (149,7) N. Therefore, the use of

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dentin posts as intra-canal retention in primary anterior teeth is a successful alternative for composite posts.

Keywords: Primary Anterior Teeth, Dentin Post, Composite Post, Pull Out Resistance.

مقارنة مقاومة السحب لنوعين من الأوتاد المستخدمة في ترميم الأسنان الأمامية المؤقتة شديدة التهدم (دراسة مخبرية مقارنة)

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الملخص:

خلفية البحث وهدفه: تمثل الأسنان الأمامية المؤقتة المتضررة بشدة والتي تحتاج إلى معالجة لبية مشكلة ذات احتمال عالي للفشل ويعود السبب في ذلك إلى الخسارة الحاصلة في البنية السنية بسبب النخر الموجود وإجراءات المعالجة اللبية بحد ذاتها. يجب على المادة المثالية لصنع الاوتاد أن تتمتع بخواص فيزيائية وميكانيكية مشابهة لتلك الخاصة بالعاج، من الاعتبارات الهامة أيضاً أن يكون لهذه المادة القدرة على الامتصاص بطريقة مشابهة للبنية السنية الطبيعية الأمر الذي يضمن بزوغاً طبيعياً للأسنان الدائمة الخلف. وفي الواقع فإن المادة الوحيدة التي تمتلك هذه الصفات هي العاج نفسه حيث مثل ظهور الأوتاد العاجية بديلاً واعداً لترميم هذه الأسنان. هدفت الدراسة الحالية إلى تقييم تأثير استخدام الأوتاد العاجية على مقاومة السحب عند استخدامها في ترميم الأسنان الأمامية المؤقتة المعالجة لبياً ومقارنتها مع أوتاد الراتنج المركب.

المواد والطرائق: تألفت عينة الدراسة من 30 سناً مؤقت أمامي تم جمعها من قسم طب أسنان الأطفال – كلية طب الأسنان – جامعة دمشق، كما تم جمع 15 سناً دائمة حديثة القلع ووحيدة الجذر تم جمعها من قسم جراحة الفم والوجه والفكين – كلية طب الأسنان – جامعة دمشق. تم استخدام جذور الأسنان الدائمة لتحضير 30 تقسيم الأسنان المؤقتة إلى مجموعتين (15 سناً في كل مجموعة).تم ترميم المجموعة الأولى باستخدام الأوتاد العاجية في حين رممت المجموعة الثانية باستخدام أوتاد الراتنج المركب وبامتداد 3 ملم للوتد في كلا المجموعتين. ثم تمت دراسة مقاومة السحب باستخدام جهاز الاختبارات الميكانيكية العام Testometric.

النتائج: تم جمع النتائج وإجراء الإحصاء الوصفي، كما تم إجراء الإحصاء التحليلي عند مستوى ثقة 95% باستخدام تحليل T-student للعينات المستقلة. أظهرت النتائج عدم وجود فروق ذات دلالة إحصائية في مقاومة السحب بين المجموعتين مع تفوق الأوتاد العاجية. (156,7) نيوتن مقارنة بأوتاد الراتنج المركب(149,7) نيوتن.

الخلاصة: أظهرت الأوتاد العاجية تفوقاً في مقاومة السحب(156,7) نيوتن مقارنة بأوتاد الراتنج المركب(149,7) نيوتن. وعليه فإن استخدام الأوتاد العاجية كمثبتات داخل قنيوبة لترميم الأسنان الأمامية المؤقتة يمثل بديلاً ناجحاً لأوتاد الراتنج المركب.

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الكلمـات المفتاحيـة: الأسـنان الأماميـة المؤقتـة – الأوتـاد العاجيـة – أوتـاد الراتنج المركب – مقاومة السحب.

Introduction:

Early childhood caries (ECC) is one of the most common dental and oral health problems in children, defined as the presence of one or more decayed teeth in children under three years of age (Phantumvanit et al., 2018). ECC is characterized by a rapidly progressing decay process that begins in the cervical third of the upper primary incisors shortly after the eruption and if left untreated, it worsens until it affects the entire crown, leading to premature tooth loss (Rajesh et al., 2014).

As mentioned earlier, ECC initially affects the upper primary incisors, the upper and lower primary molars, and the primary canines in both jaws. These cavities are associated with numerous health and social problems for the child, as demonstrated by various studies showing that children with poor oral health have a lower quality of life than those with good oral health (Mariam et al., 2021). Advanced dental caries can cause severe pain in children, negatively affecting their nutrition and ability to eat and drink, leading to malnutrition and associated growth delays. If the problem persists, these teeth may become necrotic, causing periapical lesions that act as infectious foci in the child's oral cavity (Tinanoff et al., 2019).

From an orthodontic perspective, the premature loss of primary anterior teeth before the age of three results in a loss of arch space in the anterior dental region and increases the likelihood of developing abnormal oral habits such as thumb-sucking or tongue thrusting, which can lead to malocclusion later in life (Nadelman et al., 2021a). Another negative consequence of early loss of upper primary anterior teeth is improper speech development in children, which may become permanent if it occurs early and remains untreated (Kalia et al., 2018).

On a psychological and social level, ECC causes emotional and behavioral problems in children due to the unattractive appearance of decayed teeth, which undermines their self-confidence and makes them shy and withdrawn, avoiding social interactions for fear of ridicule (Nadelman et al., 2021b).

Treating ECC is a challenge that requires collaboration between the family and the dentist (Beldüz Kara et al., 2018). Treatment depends on several factors, including the extent of the lesion, the child's age and behavior, as well as the parents' awareness and cooperation (Ripa, 1988). The first step in managing ECC is parental education and monitoring the child's oral and dietary habits to identify and eliminate harmful practices, which may take time. Subsequently, restorative treatments are implemented, where initial carious lesions are treated using glass ionomer cement or compomer after removing softened dental tissue with hand instruments (Beldüz Kara et al., 2018).

In cases of advanced lesions involving pulp damage, treatment involves pulp therapy and, if necessary, the use of short posts to provide support for coronal restoration (Seraj et al., 2015). In this regard, various post designs have been proposed for intracanal stabilization when restoring severely decayed primary anterior teeth, including inverted metal posts (Vafaei et al., 2016), loops made from orthodontic wires in different shapes (Ω) (Nilavarasan et al., 2016) or (α) (Luiz Pinheiro et al., 2007) or (γ) (Baghalian et al., 2014), carbon fiber posts (Hashem, 2005), and more aesthetic alternatives such as composite resin posts (Bahrololoomi and Mehravar, 2022; Mosharrafian and Sharifi, 2016), polyethylene posts (Memarpour and Shafiei, 2013), or fiberglass posts (Kadkhodaei et al., 2020). These options offer several advantages, such as wear resistance, biocompatibility, and desirable mechanical properties. However, these posts remain unable to replicate the biological characteristics of primary teeth, particularly their natural resorption, which allows for the normal eruption of permanent successor teeth (El-Shaabany and El-Baz, 2021).

With the introduction of dentin posts as a promising alternative for restoring severely decayed primary anterior teeth, these posts exhibit suitable properties. Theoretically, dentin posts can resorb naturally as part of the physiological shedding process of primary teeth and their replacement by permanent successors, which could be considered a unique advantage over other post types. This paves the way for dentin posts to become the optimal choice for rehabilitating severely decayed primary anterior teeth in pediatric dentistry. These posts are expected to have physical properties similar to those of natural teeth, such as modulus of elasticity, compressive strength, thermal expansion, and others (Kathuria et al., 2011; Alcântara et al., 2010).

Fracture or dislodgment of the restoration are the two main causes of failure after rehabilitating severely decayed primary anterior teeth. Therefore, stability and resistance to dislodgment forces are desirable for any restoration (Memarpour et al., 2013).

Various mechanical tests have been used to evaluate the bond strength of posts in restored teeth, including push-out tests, micro-tensile

tests, and pull-out tests, each with its own advantages. However, the pull-out test provides a closer simulation of clinical reality, as it assesses the post's stability as a complete unit along the entire root canal length (Goracci et al., 2007).

Study Objective:

This study aimed to compare the pull-out resistance of dentin posts and composite resin posts used in the restoration of severely decayed primary anterior teeth.

Materials And Methods:

The study was conducted in the Department of Pediatric Dentistry and Special Needs at the Faculty of Dentistry, Damascus University. A total of 30 primary anterior teeth, including upper incisors, upper canines, and lower canines, were collected from pediatric dental clinic patients. The inclusion criteria required teeth to have at least two-thirds of the root length remaining, intact roots free from caries or fractures, no prior endodontic treatment, and no radiographic evidence of internal resorption. Teeth were extracted due to traumatic injuries, severe early childhood caries with parental refusal of treatment, or orthodontic reasons.

Following sample collection, the crowns were sectioned 1 mm above the cementoenamel junction (CEJ) perpendicular to the long axis of the tooth to simulate clinical crown destruction. The initial working length was determined using a #10 K-file, and root canal preparation was performed with Hedstrom files up to size #40, accompanied by irrigation with 5.25% sodium hypochlorite. After drying with paper points, the canals were obturated with Metapex. Post-space preparation was carried out using Gates Glidden drills (size #4 for primary molars, size #5 for incisors/canines), extending 4 mm from the coronal pulp floor while maintaining 3 mm below the CEJ.

The teeth were randomly divided into two groups of 15 each. The first group was restored using dentin posts, while the second group received composite resin posts. For dentin post-fabrication, 15 freshly extracted single-rooted permanent teeth were collected, ensuring they had fully formed apices, no structural defects, and straight roots. The crowns were removed below the CEJ using a high-speed diamond bur, and the roots were split longitudinally to exclude the root canal. CAD/CAM milling was used to produce 15 posts with a diameter of 1.2 mm and 15 posts with a diameter of 1.4 mm, each at least 8 mm long. The posts were sterilized by immersion in 10% formalin for two weeks following CDC protocols, then rinsed and stored in saline until use.

In the composite resin post group, the dentin walls of the post space were etched with 37% phosphoric acid for 15 seconds, while enamel margins were etched for 30 seconds. After rinsing and drying, Tetric N-Bond adhesive was applied and light-cured for 20 seconds. The post space was then filled with Tetric N-Ceram composite in increments, each light-cured for 40 seconds, extending 4 mm above the CEJ. For the dentin post group, both the post and dentin walls were etched for 15 seconds, with enamel margins etched for 30 seconds. Following rinsing and drying, a Tetric N-Bond was applied and light-cured. Variolink II dual-cure resin cement was mixed, and applied with a borate brush, and the post was seated and light-cured for 40 seconds before being trimmed to 3 mm above the CEJ. The crown was then built up using Tetric N-Ceram composite in layers, shaped anatomically, and extended 4 mm above the CEJ.

All specimens underwent 500 thermal cycles, alternating between 5°C and 55°C water baths for 30 seconds each, with a 5-second transfer time. For the pull-out test, retention grooves were created on the root and composite crown using a 0.6 mm diamond bur. Teeth were embedded in acrylic resin blocks, with the root covered up to 1 mm below the CEJ and the crown restoration covered while excluding residual crown structure. An orthodontic wire loop (1 mm diameter) was incorporated into the coronal acrylic to facilitate testing. A Testometric universal testing machine was used at a crosshead speed of 0.5 mm/min, and the force at failure was recorded in newtons. Failure modes were categorized as Type 1, where the post and restoration dislodged together, or Type 2, where the coronal portion fractured while the post remained in the canal.

Statistical analysis:

Statistical analysis was performed using SPSS version 24, employing an independent t-test to compare pull-out resistance between the two groups. The null hypothesis assumed no significant difference in pull-out resistance between dentin posts and composite resin posts.

Figure (1): Prepared dentin posts.

Figure (2): Tooth embedded in acrylic resin molds.

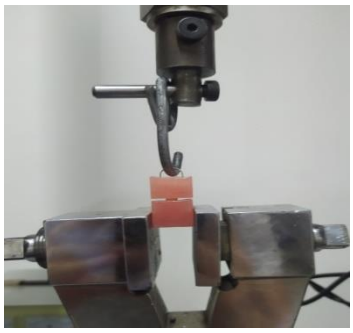

Figure (3): Conducting the test on one of the specimen

Results and Statistical Analysis:

Statistical analysis was performed using SPSS software (version 24). The mean failure forces for each group were calculated, with the composite resin post group showing an average failure force of 149.7 N, while the dentin post group exhibited an average of 156.7 N, as presented in Table 1 and Chart 1.

An independent Student's t-test was conducted to compare the mean failure forces between the two groups. At a 95% confidence level, the *p*-value was 0.53, indicating no statistically significant difference in mean failure forces between the groups, as detailed in Table 2. Additionally, the frequencies and percentages of failure modes (Type 1 and Type 2) were recorded for both groups, as illustrated in Table 3 and Chart 2.

Table (1): Descriptive statistics of pull-out resistance (in Newtons) for the two study groups

Groups	n	Mean	SD	SE	Min	Max
Dentin posts	15	156.7	39.755	10.270	103.9	227.5
Composite resin posts	15	149.7	39.116	10.100	86.2	219.1

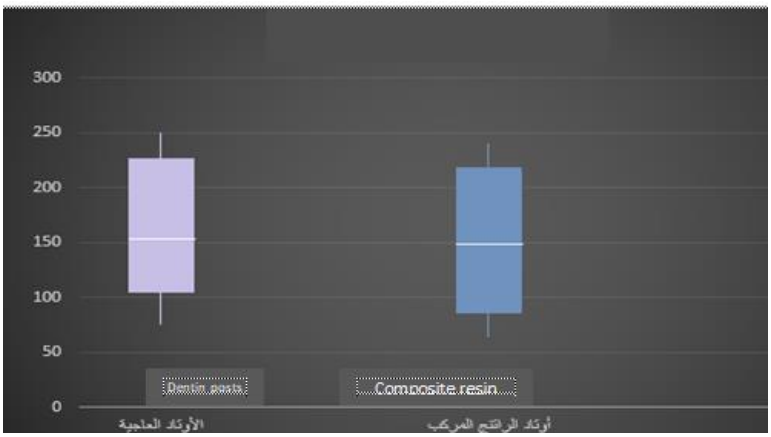

Chart (1): Descriptive statistics of pull-out resistance (in Newtons) for the two study groups

Table(2): Independent samples t-test results for pull-out resistance comparison

Variable	Mean difference	t-test	df	*p*-value
Pull-out resistance	7	0.242	28	0.53

Table (3): Percentage frequencies of failure modes in the two study groups

groups	Frequency			Percentage		
	Failure type I	Failure type II	Total	Failure type I	Failure type II	Total
Dentin posts	15	0	15	100%	0%	100%
Composite resin posts	9	6	15	60%	40%	100%
total	24	6	30	80%	20%	100%

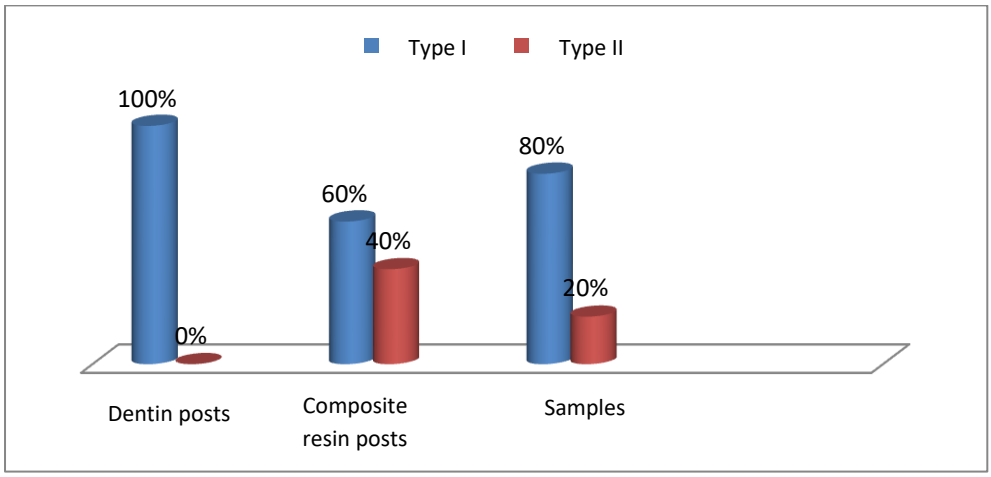

Chart (2): Percentage distribution of failure modes in both study groups

Discussion:

Maintaining intact primary occlusion is crucial for a child's development, ensuring proper function, speech, aesthetics, space preservation for permanent successors, and preventing harmful oral habits (Jain et al., 2011). A common challenge in pediatric dentistry is restoring severely decayed primary anterior teeth, often seen in early childhood caries or traumatic injuries, which compromise masticatory efficiency and vertical dimension and may lead to dysfunctional habits (e.g., tongue thrusting, mouth breathing) and malocclusion, alongside aesthetic and psychosocial impacts (Ghazawy & Badran, 2018). Restoring these teeth is complicated by young age-related behavioral management difficulties, small crown size, and large pulp chambers, limiting the remaining tooth structure (Papathanasiou et al., 1994; Verma & Passi, 2011). Structural differences between primary and permanent teeth further reduce bonding strength (Uekusa et al., 2006). While composite resin is preferred for its aesthetics and durability (Waggoner, 2002), endodontic-treated teeth often require intraradicular posts for reinforcement (Qualtrough & Mannocci, 2003). This study evaluated two post types: composite resin posts chosen for their biocompatibility, mechanical properties, and cost-effectiveness (Gujjar & Indushekar, 2010; Braga et al., 2002; Bonfante et al., 2007), and dentin posts, which uniquely undergo physiological resorption alongside primary teeth (El-Shaabany & El-Baz, 2021; Ghazawy & Badran, 2018). The primary failure modes of such restorations are fracture or dislodgment, making pull-out resistance critical (Memarpour et al., 2013). Among mechanical tests, pull-out testing was selected for its clinical relevance in assessing post-stability along the entire root canal (Goracci et al., 2007). Results showed no statistically significant difference in bond strength between dentin posts (mean: 156.7 N) and composite resin posts (mean: 149.7 N), aligning with studies by Luiz Pinheiro et al. (2007) and Pithan et al. (2003). Discrepancies among studies may stem from variations in post-design, cementation protocols, or dentin post-preparation. Memarpour et al. (2013) reported superior performance of mushroom-shaped composite posts due to enhanced mechanical retention, while Al-Fil & Wolfov's study (2022) found fiber-reinforced composite posts most resistant to dislodgment. Failure analysis revealed Type 1 failure (post-restoration displacement) as dominant (100% dentin, 60% composite), attributed to inadequate dentin drying, air bubbles in cement, or polymerization shrinkage (Memarpour et al., 2013; Deliperi, 2008). Type 2 failure (coronal fracture with retained post) occurred only with composite posts (40%), likely due to moisture contamination during layering. These findings corroborate prior studies (Memarpour et al., 2013; Al-Fil & Wolfov, 2022).

Conclusion:

Dentin and composite resin posts exhibited comparable pull-out resistance, though dentin posts showed marginally higher means. Type 1 failure predominated, and dentin posts' theoretical resorbability makes them a promising option for severely decayed primary anterior teeth. Clinical studies are needed to validate these in vitro results.

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المراجع العربية:

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