

A COMPARASION OF BRACKET DEBONDING FORCES BETWEEN THE TWO ADHESIVES: CON TEC LC AND CON TEC DUO

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Abstract: Fixed technique for applying brackets would be impossible without using adhesives for their fixation to the tooth enamel. However, the use of adhesives entails a number of problems which are a consequence of their imperfection, besides the fact that they have been actually applied for a number of decades already.

The paper will analyze the debonding force values for bracket-tooth interface by using *Con Tec LC and, Con Tec Duo*.

For comparative analysis of the strength of bracket-tooth interface, with the application of different types of adhesives, 80 extracted teeth of the frontal region were used (maxillary and mandibular incisors and canines).

For the debonding process of applied orthodontics brackets, single-axial *Stretch system* for examination of tissues was applied to determine the value of the force necessary to separate the bracket from tooth surface, i.e. it was used to test debonding force. The direction of the used force for debonding was under angle of 90 degrees to the vertical axis of the tooth.

By comparison of mean values of the strength of interface among the tested groups, it was determined that the highest average value of bond strength was with the group of teeth with which *Con Tec Duo* was used, a little lower mean value was recorded with the use of *Con Tec LC* adhesive.

Keywords: adhesives, orthodontic bracket, debonding, stretch system.

1. INTRODUCTION

Orthodontics, as a science and practice, has developed through its history depending on the development of biology, medicine and technique. Advancement of technique in general and the knowledge derived from it made possible the use of that information to design orthodontic devices with certain elements comprising orthodontic device itself: **bracket**, screws, wires, rubber cups for traction, rubber bands etc, with quite precisely defined characteristics required by the therapy, all of which makes work significantly easier and provides a safer therapy outcome [1,2].

One of the problems encountered relatively frequently by an orthodontist in his everyday work while using the fixed technique is the occurrence of failure of brackets fixed to the tooth by adhesive. This requires re-application of the bracket, implying a waste of time both for the patient and the therapist, and entails other consequences too. One of the consequences is that if the bracket fails for the second

time, it is not advisable to adhere it for the third time.

Numerous studies of the material used for bonding brackets have been undertaken because of the reasons mentioned above. These materials differ both by their chemical composition, the curing method, sensitivity to moist environment during bonding of brackets etc., as well as by the existence of extensive correlative dependence between these elements. This additionally complicates the deriving of absolutely safe conclusions as to "which is the best adhesive agent for bonding brackets in every specific case", depending on the age of the patient etc.

Taking into account the importance of the mentioned problems and the views of these processes and phenomena that are frequently contradictory, we have chosen this study in order to exactly determine the difference between the various types of *adhesives (bonding agents)*, in terms of their adhesiveness, the course and comfort during work, with an aim to precisely define the guidelines

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and operating instructions for specific types of adhesives.

Nowadays, based on extensive research, there is a belief that the strength of bracket-tooth interface within the range 3–7 MPa is satisfactory for the clinical work of an orthodontist [3–5], while the other authors state a somewhat bigger range of values 2,8–10 MPa [6–7], whereas, according to Newman [8] et al., an acceptable minimum of the bond strength with regards to etched enamel ranges between 6–8 MPa. On the one hand, orthodontists require as safe (strong) adhesive bond as possible, thus decreasing the possibility of undesired separation of the bracket (bracket failure) during the therapy; on the other hand, a stronger enamel-adhesive bond increases the risk of damaging tooth enamel during debonding [9–11]. It is a more fortunate circumstance if during debonding bracket is separated from the adhesive, with adhesive remaining on the tooth, rather than a situation where adhesive is bonded more strongly to the bracket, thus, separating adhesive together with the bracket may entail damage of enamel if the enamel-adhesive bond is strong. In the former case it is better to carefully remove the remaining part of the adhesive on the tooth with hard polishing rubber cups, rather than with turbine and diamond drill. This enamel damage that occurs relatively frequently should be repaired according to certain generally accepted principles that apply to such cases and situations.

2. MATERIALS AND METHODS

80 extracted teeth of the frontal region (central, lateral incisors and molars of upper and lower dental arch) were used for comparative analysis of bracket-tooth bond strength for application of Con Tec LC and Con Tec Duo adhesives. The criteria for teeth selection for the study were the following: no caries on labial surface, no cracks of enamel that can be caused by the pressure of forceps during tooth extraction, no hypoplastic macroscopically visible areas, and no decalcification caused by any reason.

The common procedure of tooth preparation for bonding brackets (regardless of adhesive type) was in accordance with the procedure that is most commonly used for *in vitro* studies [12–14].

The procedure consisted of storing the freshly extracted human teeth in a solution of 0.1% (weight/volume) thymol. Teeth were cleansed and polished. The procedure of bonding brackets to teeth was done only after finishing the preparation (Figure 1).



Figure 1. Bracket bonded on a molar (prepared for experimental analysis).

During bonding brackets, a protocol was applied determined by the requirements, i.e. manufacturer's instructions for each of the mentioned adhesives used in the study, i.e. the adhesives tested for the purpose of comparative analysis of bracket-tooth bond strength.

The study was done *in vitro* as this was done by many other investigators before [15–20] who tested certain characteristics of adhesive types in order to understand their specific properties, advantages and shortcomings compared to each other. An *in vitro* study of adhesives is more favorable compared to *in vivo* study, because it eliminates the factor of speed of work depending on researcher's dexterity, thus reducing the possibility of contamination of the working area with saliva, (which in turn reduces the adhesive strength of the bonding agent), having in mind that most adhesives are sensitive to moist as "one of the most common causes for bracket failure". Besides, laboratory study may indicate a potential clinical success in certain conditions [21].

In order to avoid the influence of type of the bracket on bracket-tooth bond strength, the same type of metal bracket *Discovery Slot 0,56 x 0,76 mm / 22 x 30 inch, Cuspid brackets with hooks* was used with tested adhesives.

Con Tec LC adhesives were used with the first group, in which curing was done by chemical activation, while in the second group *Con Tec Duo* adhesives were used which are chemically and light-cured.

The process of debonding of placed orthodontic brackets aimed at determining the size of force necessary to separate the bracket from tooth surface was measured in the *Centre for Bioengineering of Kragujevac University*. For the purpose of this study, the Centre for Bioengineering modified its device, a single-axial *Stretch system* for tissue testing [22–24], so that a new sensor for force of 300 N was mounted and used to test the force of separation of bracket from the tooth. The device on which test-

ing was done is presented in Fig. 2, and the position of the tooth before starting debonding is presented in Fig. 3. The direction of application of debonding force was at a 90 degree angle at the vertical axis of tooth.

Tensile force was accomplished at constant speed of 1 mm/min. The device automatically recorded the force with 0.3 N accuracy. The graph presents the forces in the function of time with 0.15 second intervals.



Figure 2. Device on which study was performed (Stretch system)



Figure 3. Position of tooth in the device Stretch system, before starting debonding

3. RESULTS

The values of debonding force on the *upper and lower dental arches* are presented in Table 1 for each tooth separately. The table presents the obtained values for all teeth within the groups (sample 40) tested with Con Tec LC and Con Tec Duo adhesives, whereas Table 2 presents the results of statistical analysis of debonding force for adhesive Con Tec LC and Table 3 the results for adhesive Con Tec Duo.

Table 1. Debonding forces for upper and lower dental arches for Con Tec LC and Con Tec Duo adhesives

ConTec LC	Debonding force (N)	Tooth arch	Type of tooth	ConTec Duo	Debonding force (N)	Tooth arch	Type of tooth
18.	42,43	L	1,2	8.	48,78	L	1,2
8.	42,52	L	1,2	18.	48,95	L	1,2
28.	42,61	L	1,2	38.	51,86	L	1,2
38.	42,91	L	1,2	13.	55,45	L	1,2
3.	49,03	L	1,2	3.	56,23	L	1,2
23.	49,13	L	1,2	28.	56,32	L	1,2
33.	49,81	L	1,2	23.	56,83	L	1,2
13.	50,08	L	1,2	17.	58,73	L	1,2
17.	54,89	L	1,2	33.	59,64	L	1,2
7.	55,25	L	1,2	15.	60,78	L	1,2
27.	55,28	L	1,2	7.	61,12	L	1,2
37.	55,81	L	1,2	27.	61,12	L	1,2
15.	57,96	L	1,2	37.	61,83	L	1,2
5.	58,21	L	1,2	5.	63,27	L	3
25.	58,46	L	3	25.	63,75	L	3
35.	58,81	L	3	35.	68,52	L	3
22.	63,73	L	3	22.	68,98	L	3
2.	63,84	L	3	2.	70,08	L	3
12.	64,18	L	3	12.	70,14	L	3
32.	64,81	L	3	32.	71,47	L	1,2
30.	82,98	U	2	20.	90,89	U	2
10.	83,08	U	2	30.	92,34	U	2

ConTec LC	Debonding force (N)	Tooth arch	Type of tooth	ConTec Duo	Debonding force (N)	Tooth arch	Type of tooth
40.	83,11	U	2	10.	94,09	U	2
20.	83,15	U	2	40.	94,48	U	2
6.	90,49	U	2	26.	98,79	U	2
26.	90,51	U	2	6.	99,74	U	2
36.	90,59	U	2	36.	99,87	U	2
16.	91,05	U	2	16.	102,87	U	3
9.	104,11	U	3	9.	111,78	U	3
19.	105,06	U	3	29.	116,67	U	2
29.	105,13	U	3	39.	116,67	U	3
39.	105,81	U	3	19.	120,43	U	3
14.	113,98	U	3	24.	124,25	U	3
4.	114,77	U	3	14.	124,34	U	3
24.	114,96	U	1	34.	127,43	U	1
34.	115,07	U	1	21.	128,67	U	1
11.	117,13	U	1	31.	128,69	U	1
21.	118,21	U	1	4.	128,97	U	1
1.	118,32	U	1	1.	130,12	U	1
31.	118,57	U	1	11.	137,76	U	1

Table 2. Results of statistical analysis of debonding force for adhesive ConTec LC

Descriptive parameter (Debonding force (N) – adhesive ConTecLC)	Dental arch		Total
	Upper	Lower	
N	20	20	40
MIN	82,98	42,43	42,43
MAX	118,6	64,81	118,57
I	35,59	22,38	76,14
Mo	-	-	-
Me	105,1	55,27	73,90
Xsr	102,3	53,99	78,15
SD	13,88	7,59	26,84
CV	13,57	14,06	34,35

Table 3. Results of statistical analysis of the bond strength obtained with ConTec Duo adhesive

Descriptive parameter (Debonding force (N) – adhesive ConTec Duo)	Dental arch		Total
	Upper	Lower	
N	20	20	40
MIN	90,89	48,78	48,78
MAX	137,76	71,47	137,76
I	46,87	22,69	88,98
Mo	116,67	61,12	61,12
Me	116,67	60,95	81,18
Xsr	113,44	60,69	87,07
SD	15,33	6,83	29,17
CV	13,51	11,25	33,50

Table 4 presents comparative results of statistical analysis for debonding force with the application of Con Tec LC i.e. Con Tec Duo adhesives.

The obtained total results for debonding force of teeth of the upper and lower dental arch show that

the biggest average value $X_{sr} = 87,07$ N was obtained with the group of teeth in which *Con Tec Duo* adhesive was used for bonding brackets, whereas a somewhat lower average value $X_{sr} = 78,15$ N was

obtained with the group of teeth in which *Con Tec LC* was used.

The results of testing of significance of differences by t-test show that there is no statistically sig-

nificant difference between the mean values of debonding forces for brackets fixed with *Con Tec LC* and *Con Tec Duo* adhesives ($p= 0,158601$).

Table 4. Comparative results of statistical analysis for parameter F (debonding force) with tested adhesives – total results (summary for all tested teeth of the upper and lower tooth arch)

Analysed statistical elements for parameter F (debonding force)	<i>ConTec LC</i>	<i>ConTec Duo</i>
N	40	40
MIN	42,43	48,78
MAX	118,57	137,76
I	76,14	88,98
Mo		61,12
Me	73,90	81,18
Xsr	78,15	87,07
SD	26,84	29,17
CV	34,35	33,50

4. CONCLUSIONS

Based on a comparative analysis of the results of the debonding force with tested adhesives for fixing brackets to tooth enamel, the following conclusions may be drawn:

The comparison of mean values of debonding forces between tested adhesives showed that the highest average value of debonding force was with the group of teeth in which adhesive *Con Tec Duo* was used, whereas somewhat lower value was obtained by use of *Con Tec LC* adhesive.

The results that gave a clear insight in the bracket-tooth bond strength achieved by the tested adhesives that are nowadays most commonly used in practice have the following clinical-theoretical implications.

If the degree of tooth dislocation is bigger, which requires higher activation of arch, i.e. stronger force to move the tooth, it is necessary to use the adhesive by which the strongest tooth-bracket bond is achieved, in order to avoid undesirable failure of the bracket (*Con Tec Duo*).

If the degree of disruption of tooth position is smaller, adhesives that achieve a lower bracket-tooth bond may be used too (*Con Tec LC*).

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ПОРЕЂЕЊЕ СИЛЕ ЗА ДЕБОНДИРАЊЕ БРАВИЦА КОД ДВА АДХЕЗИВА: CON TEC LC И CON TEC DUO

Сажетак: Фиксна техника за примјену бравица би била немогућа без употребе адхезива за њихово фиксирање за зубну глеђ. Међутим, употреба адхезива повлачи неколико проблема који су последица њихове несавршености, присутне без обзира на то што се они практички примјењују већ неколико деценија.

У раду се анализирају вриједности силе дебондирања за везу бравица–зуб кориштењем *Con Tec LC* и *Con Tec Duo*.

У сврху компаративне анализе јачине везе бравица-зуб, са употребом различитих врста адхезива, кориштено је 80 извађених зуба фронталне регије (сјекутићи и кутњаци у горњој и доњој вилици).

У поступку дебондирања стављених ортодонтских бравица, примијењен је једноосни *Stretch system* за испитивање ткива, како би се одредила вриједност силе потребне за одвајање бравице од површине зуба, одн. овај систем је употребљен за тестирање силе дебондирања. Правац примијењене силе дебондирања је био под углом од 90 степени у односу на вертикалну осу зуба.

Поређењем средњих вриједности јачине везе између тестираних група, одређено је да је највиша просјечна вриједност јачине везе код групе зуба код које је употребљен *Con Tec Duo*, а нешто нижа средња вриједност евидентирана је код употребе *Con Tec LC* адхезива.

Кључне ријечи: адхезиви, ортодонтска бравица, дебондирање, систем растезања.

