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# Breakage Incidence with Direct Bonded Lingual Retainers

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**Abstract:** *This study examined the effects of a number of patient and clinical variables on the breakage of bonded retainers, and consisted of a retrospective review of the survival of 200 bonded retainers. Data was collected from two clinical centres between November 1996 and February 1997. The subjects comprised 198 patients of both sexes divided into three age groups. Retainers at both centres were made in 018-inch co-axial wire with Relyabond and Helioprogress adhesives used at each respective centre.*

*The effects on time to first breakage of adhesive, patient sex, and arch (upper/lower) were considered using Kaplan Meier survival graphs and in Log Rank Tests. Finally, a Cox Proportional Hazard Model was used to examine the joint effects of these factors and the patients' ages. Breakage over a 5-year period with Relyabond was 38·8 per cent upper, 22·1 per cent lower, and with Helioprogress 75 per cent upper and 23·2 per cent lower.*

*Breakage appears to be unrelated to the materials used or to the age and sex of the patients. Upper retainers break more often than lowers (P = 0·016) and early breakage is more likely to occur at an adhesive pad than at a wire (9·6 versus 2·5 per cent within 6 months).*

*Index words:* Adhesive Pads, Breakage Incidence, Direct Bonded Lingual Retainers, Retainer Wire.

## Introduction

The direct bonding of multi-stranded wires to the lingual or palatal surfaces of incisor teeth has been in popular use as a method of retention since the late 1970s (Zachrisson, 1977, 1983, 1985, 1986a,b; Becker & Goultschin, 1984; Bantelon & Droschl, 1988; Dahl & Zachrisson, 1991; Artun *et al.*, 1997). Several studies have examined the effects of different wire sizes on the incidence of breakage.

Zachrisson began experimenting in 1977 with direct bonded retainers using 0·032- and 0·036-inch blue elgiloy bonded to canines and closely adapted to incisors. His study of 43 cases showed five breakages occurring between 1 and 19 months. He progressed to the use of 0·020-inch spiral wire in a case report in 1983; his conclusion was that such retainers should always be constructed by an indirect method on a stone working model.

The work of Dahl & Zachrisson (1991) evolved into a definitive study of 166 retainers bonded to all six anterior teeth, 85 were constructed in three stranded 0·0195 and 0·0215-inch spiral wire and 81 in five stranded 0·0215-inch spiral wire. They reported breakage rates of 25 per cent in the maxilla and 10·3 per cent in mandible with three spiral wire retainers and 7·8 and 5·0 per cent, respectively, with five spiral wire retainers all over a 5-year period. Almost 50 per cent of breakage have occurred within the first year.

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Other researchers have used similar types of retainer. Becker and Goultschin (1984) developed a 0·018- and 0·022-inch multi-strand bonded to canines only, and 0·0195- and 0·0215-inch multi-strand bonded to all six anterior teeth. This study included 94 retainers with a breakage rate after 5 months of 55 per cent in the upper arch and 13 per cent in the lower arch. They developed a 0·018- and 0·022-inch multi-strand canine to canine retainer, but published no exact figures on breakage, and Bantelon and Droschl (1988) described an indirect method of fabrication of retainers using 0·032-inch wire in the lower arch.

A recent paper by Artun *et al.* (1997) considered breakage in a study of 35 fixed retainers constructed in three different forms, thick plain round wire bonded to canines only, thick spiral wire bonded to canines only, and thin spiral wire bonded to all six anterior teeth.

Of the total number of retainers, 22·9 per cent broke in the following distribution: 30·8 per cent thick wire, 9·1 per cent thick spiral wire, and 27·3 per cent thin spiral wire. Results were collected over a 3-year period, the largest number of failures occurring during the third year.

In summary, spiral or multi-strand wire appear to be the most popular for direct bonded retainers. Upper retainers break more frequently than lowers, but there is no agreement regarding survival times.

The present study outlines the construction and fitting of retainers using a method similar to that of Dahl and Zachrisson. (1991), and aims to investigate the effects of a number of patient and retainer variables on the survival of fixed retainers.

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## Materials

The subjects comprised 198 patients, all of whom had received fixed appliance treatment in the retained arches with the Roth 0·022-inch prescription SWA appliance. Twenty-two patients had upper bonded retainers and 178 patients had lower bonded retainers (two patients had upper and lower retainers). All bonded retainers were constructed in 0·018-inch Perform Co Axial wire, and placed by the first author in two different practices (Stirling and Falkirk). The Stirling sample was bonded using Reliance Relyabond adhesive, light-cured with a Kent Dental UV curing light. The Falkirk sample was bonded using Vivadent Helioprogress adhesive, light-cured with a Vivadent UV curing light. The details are given in Table 1.

The mean age of patients at retainer fitting was 15·5 years. Sixty-four per cent of retainers were fitted to the 12–16-year-old age groups, 25 per cent to the 17–20-year-old age groups, and 11 per cent to the remaining over 20-year-old age group. There were no significant age differences between the two samples.

Data was collected from consecutive retainer cases examined over a period of 3 months between November 1996 and February 1997. The age of the retainers at the sampling point is given in Table 2.

## Methods

All retainers in the study were made and bonded by the same operator using the following sequence of construction.

Impressions were taken over the brackets without the archwire in position and working models were cast in hard stone. Interstitial cuts were made between the incisors using a large diamond disc. (Figure 1). A 0·8-inch SS wire was shaped along the labial surfaces of the incisors and canines. A section of 0·018-inch coaxial wire was contoured to fit the lingual surfaces of incisors and canines. The wire was then heat-treated to cherry red, quenched, and refitted to the model. The retainer was then gently pulled into intimate contact with the tooth surfaces on the model using 0·010-inch soft SS ligature wire round the labial carrier wire. (Figure 2).

The following clinical method of fitting was employed.

The appliance was debonded, and the teeth were thoroughly cleaned and polished using oil-free pumice. Light abrading of the lingual enamel was carried out with a green stone. The lingual surfaces were etched with 37 per cent phosphoric acid for 15 seconds and thoroughly washed. The lingual surfaces were thoroughly dried, and a very thin layer of primer was applied and blown into the etched prisms with the 3 in 1 syringe, and light-cured for 10 seconds. The fit of the retainer was checked and minor adjustment carried out if necessary. Small amounts of composite were placed on the lingual surfaces of the six anterior teeth ensuring maximum coverage in mesio-distal width. The retainer wire was placed over the composite and gently pushed into position. The composite pads were light-cured for 10 seconds per tooth, both lingually and by labial trans-illumination. Further composite was added to completely cover the wire surface except between the teeth, and further light curing was carried out for 10 seconds per tooth. The surface of the retainer was checked and polishing was usually unnecessary.

TABLE 1 *Distribution of retainers*

| | Relyabond | Helioprogress |
|---|---|---|
| Males | 42 | 26 |
| Females | 97 | 33 |
| **Total** | **139** | **59** |
| Upper | 18 | 4 |
| Lower | 122 | 56 |
| **Total** | **140** | **60** |

TABLE 2 *Age of sample of retainers*

| Age of sample of retainers | Relyabond | Helioprogress |
|---|---|---|
| Under 6 months | 17 (12·20%) | 5 (8·40%) |
| 6 months–1 year | 24 (17·20%) | 11 (18·60%) |
| Over 1 year | 38 (27·20%) | 21 (35·50%) |
| Over 2 years | 37 (26·40%) | 13 (22%) |
| Over 3 years | 18 (12·80%) | 8 (13·50%) |
| Over 4 years | 6 (4·20%) | 2 (2%) |

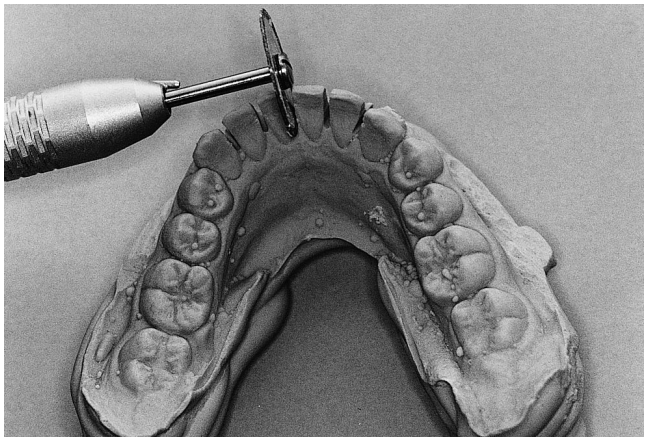

FIG. 1 Interstitial trimming of incisors on model.

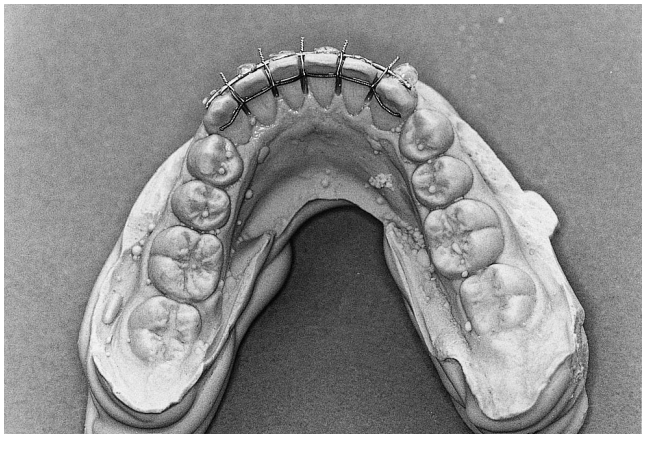

FIG. 2 Retainer wire fitted on model.

*Information collected*

In addition to sex and age when the retainers were fitted, the following information was collected for each patient.

1. Treatment centre at which retainer was placed (Stirling or Falkirk).
2. Arch to which retainer was fitted.
3. Site of breakage and whether pad or wire.
4. Survival time in months.

*Statistical methods*

*Statistical analysis of survival/breakage.* The effects of three factors that might influence the time to first breakage of retainers were considered using Kaplan–Meier survival graphs (Figures 3–5).

1. Bonding material (Relyabond/Helioprogress).
2. Sex of patient (male/female).
3. Arch (upper/lower).

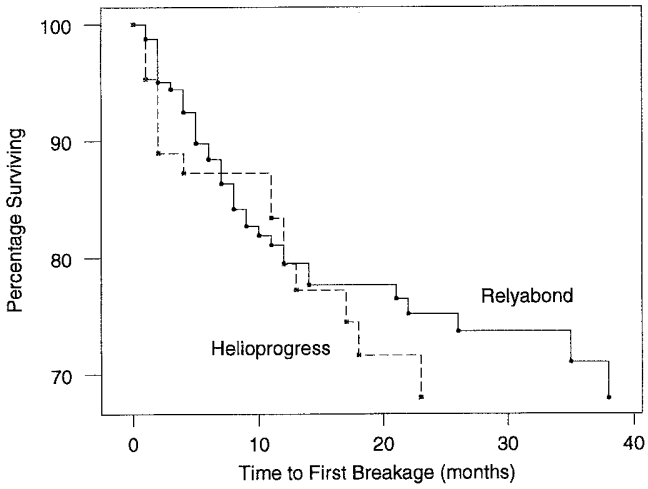


FIG. 3 Effect of adhesives on time to first breakage.

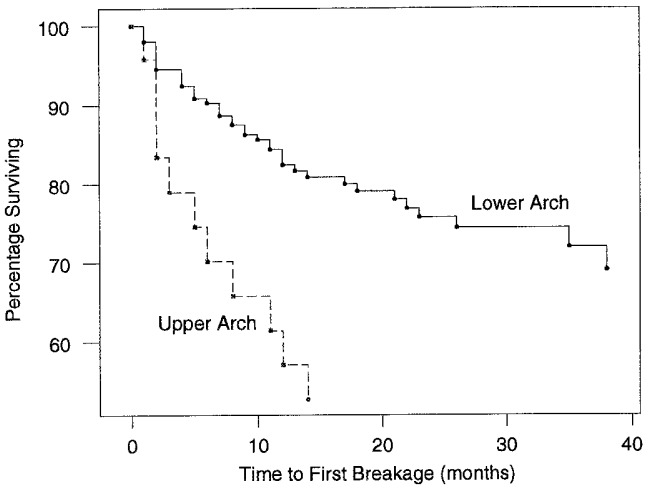


FIG. 4 Effect of arch treated on time to first breakage.

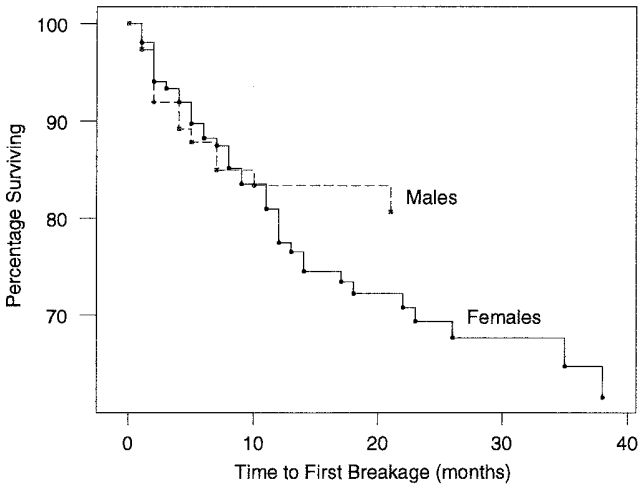


FIG. 5 Effect of patient sex on time to first breakage.

In each case, a Log Rank Test was carried out to compare formally the distribution of survival times in the two groups and, finally, a Cox Proportional Hazard Model was used to examine the joint effects of these three factors and the age of the patient.

Whether breakage is more likely at an adhesive pad or the retainer wire requires an approach different from the previous survival analysis.

Approximate 95 per cent confidence intervals for the difference between multi-nominal proportions were calculated to determine whether there is a significant difference between the proportions of breakage that occur at the pad and at the wire.

These intervals were calculated separately using all patients who had been followed for periods of at least 6 months, at least 1 year, and at least 2 years, and related to the proportions of breakage in the first 6 months, the first year, and the first 2 years respectively.

## Results and discussion

From the log rank test, a chi-square value of 0·2 ($P = 0{\cdot}675$) confirms that there is no significant difference between the distributions of time to first breakage for the two materials and systems of light curing.

A chi-square value of 2·2 ($P = 0{\cdot}136$) shows, in contrast to our subjective impression, that there is no significant difference between the distributions of time to first breakage for females and males. This remained the conclusion when the log rank test was repeated separately for the two treatment groups. A chi-square value of 2·7 ($P = 0{\cdot}1$) for Helioprogress; chi-square value of 2·7 ($P = 0{\cdot}471$) for Relyabond.

A chi-square value of 6·2 ($P = 0{\cdot}0128$) confirms that upper retainers break more quickly, on average, than lower retainers. When all these factors and age were entered into a Cox Proportional Hazards Model, again only the arch treated was significant ($P = 0{\cdot}016$). Tables 3 and 4 show that, at the end of all three specific follow-up periods, there had been more breakages at a pad than at a wire in this sample of retainers.

Analysed patients were followed for at least 2 years and

TABLE 3 *Proportion of breakages at pad and wire in three specific time periods*

| Time period | Breakage type | Proportion |
|---|---|---|
| At least 24 months | Pad | 18 (18·6%) |
| | Wire | 13 (13·4%) |
| Total sample | | 97 |
| At least 12 months | Pad | 27 (16·4%) |
| | Wire | 11 (6·7%) |
| Total sample | | 165 |
| At least 6 months | Pad | 19 (9·6%) |
| | Wire | 5 (2·5%) |
| Total sample | | 198 |

TABLE 4 *Confidence intervals for proportions of breakages at pad and wire in three specific time periods*

| Patients followed for at least | 6 Months | 12 Months | 24 Months |
|---|---|---|---|
| CI for propagation of PAD breakages | 0·061–0·143 | 0·107–0·220 | 0·120–0·275 |
| CI for proportion of WIRE breakages | 0·010–0·581 | 0·029–0·105 | 0·066–0·202 |
| CI for differences in proportions (PAD-WIRE) | 0·023–0·116 | 0·025–0·169 | –0·060–0·164 |

there was a 5 per cent difference between the proportion of breakages. However, a confidence interval for this difference in proportions contains zero suggesting that the difference is not statistically significant. Nevertheless, the fact that there is a small sample size means that there is a large variation in the point estimate making any difference difficult to establish statistically.

There were significant differences between the proportions of breakages at pad and wire for patients followed for at least 12 and 6 months. Early breakage is more likely to occur at a pad than at a wire.

The proportion of wire breakages appear to increase by a factor of two as the time patients were followed doubles from 6 to 12 to 24 months. This pattern would suggest that the proportion of wire breakage is directly affected by the time that the retainers are worn. Breakages at pads do not follow the same pattern, since many occur very soon after the retainer is fitted and the proportions are approximately the same for patients followed for 12 or 24 months.

The bonding materials used, and the sex and age of patients appear to have no statistical significance in the breakage of retainers. However, there is clear evidence that retainers in the upper arch are much more likely to fail than in the lower arch, confirming the findings of Dahl and Zachrisson (1991).

The survey also shows that the proportion of retainers surviving breakage decreases as their time in the mouth increases. In the case of breakages at the wire, there is a direct relationship between the proportion breaking and time. These findings are similar to those of Artun *et al.* (1997)

It seems likely that faulty technique and inadequate moisture control are the principal causes of failure. Careful preparation and adaptation of the wire along with strict moisture control, and adequate amount and distribution of adhesive are all essential practical steps towards success with bonded retainers.

## Conclusions

1. Breakage of retainers appears to be unrelated to the materials or the curing lights used in this survey.
2. Breakage of retainers is unrelated to the sex or age of patients.
3. Upper retainers break much more often than lowers.
4. Early breakage of an adhesive pad is more likely to occur than breakage of a wire
5. Breakage of wire is directly related to the age of the retainer: the longer it is *in situ* the greater the chance of breakage

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## References

**Artun, J., Spadafora, A. T. and Shapiro, P. A. (1997)**
A 3 year follow-up study of various types of orthodontic canine to canine retainers,
*European Journal of Orthodontics*, **19,** 501–509.

**Bantelon, H. P. and Droschl, H. (1988)**
A precise and time saving method of setting up an indirectly bonded retainer,
*American Journal of Orthodontics and Dentofacial Orthopaedics*, **93,** 78–82.

**Becker, A. and Goultschin, J. (1984)**
The multi-stranded retainer and splint,
*American Journal of Orthodontics and Dentofacial Orthopaedics*, **85,** 470–474.

**Dahl, E. H. and Zachrisson, B. U. (1991)**
Long term experience with direct bonded lingual retainers,
*Journal of Clinical Orthodontics*, **25,** 619–630.

**Zachrisson, B. U. (1977)**
Clinical experience with direct bonded orthodontic retainers,
*American Journal of Orthodontics and Dentofacial Orthopaedics*, **71,** 440–448.

**Zachrisson, B. U. (1983)**
The bonded lingual retainer and multiple spacing of anterior teeth,
*Journal of Clinical Orthodontics*, **17,** 838–844.

**Zachrisson, B. U. (1985)**
Bonding in orthodontics,
In: *Current Principles and Techniques* (eds T. M. Graber and B. F. Swain),
C.V. Mosby Company, St Louis, pp. 485–563.

**Zachrisson, B. U. (1986a)**
Adult retention, a new approach in orthodontics,
In: *State of the Art; Essence of the Science* (ed. L. W. Graber),
C.V. Mosby Company, St Louis, pp. 310–327.

**Zachrisson, B. U. (1986b)**
JCO interviews in excellence in finishing,
*Journal of Clinical Orthodontics*, **20,** 460–482, 536–556.