Wear of Ball Attachments After 1 to 8 Years of Clinical Use: A Qualitative Analysis

Olivier Fromentin, DDS, PhD[a]/Claire Lassauzay, DDS, PhD, HDR[b]/Samer Abi Nader, DDS, PhD[c]/
Jocelyne Feine, DDS, MS, HDR[d]/Rubens F. de Albuquerque Junior, DDS, PhD[e]

The purpose of this study was to analyze and compare scanning electron microscopy (SEM) observations of ball attachments that had been worn by patients during three periods of clinical use. One hundred forty-four specimens of ball anchor attachments (gold alloy matrix and titanium patrix) were studied by SEM after periods of approximately 1, 3.5, and 8 years of clinical use. Twenty new attachment components were examined as controls. SEM images revealed signs of mechanical wear for the ball attachments studied. The surfaces of the titanium patrix were associated primarily with roughening after short-term use, whereas surfaces of the gold alloy matrix showed wear, roughening, and loss of microscopic material in the form of flakes. Severe mechanical wear on both surfaces was noted after longer periods of use. The mechanical changes were not correlated with patient-mediated observations regarding the time-dependent retentive efficacy of the attachments. One year of clinical wear appeared to have limited effect on the ball attachment tested. Conversely, longer periods of use led to marked modifications in shape of the matrix and patrix components. *Int J Prosthodont 2011;24:270–272.*

Maintenance requirements for removable implant-supported prostheses are considered to be an important issue.[1] Routine maintenance for retentive ball attachments includes adjustment or replacement of inadequately retentive ball housings to compensate for clinical wear.[2–4]

The objective of this qualitative study was to analyze and compare scanning electron microscopy (SEM) observations of three groups of ball attachments that had been worn by patients for approximately 1, 3.5, and 8 years. The hypothesis tested was that there would be no major modification in the shape of both attachment components when compared at these periods of clinical wear.

[a]*Associate Professor, Paris 7- Denis Diderot University, Unité de Formation et de Recherche (UFR) of Odontology, Paris, France; Service of Odontology, Hôtel-Dieu Hospital, Assistance Publique-Hôpitaux de Paris, Paris, France.*
[b]*Associate Professor, Université Clermont 1, UFR Odontologie, Clermont-Ferrand, France; Centre Hospitalo-Universitaire Clermont-Ferrand, Service d'Odontologie, Clermont-Ferrand, France.*
[c]*Associate Professor, Department of Restorative Dentistry, Faculty of Dentistry, McGill University, Montreal, Quebec, Canada.*
[d]*Professor and Director of Graduate Studies, Faculty of Dentistry, McGill University, Montreal, Quebec, Canada.*
[e]*Professor, Department of Restorative Dentistry, Faculty of Dentistry, McGill University, Montreal, Quebec, Canada; Faculdade de Odontologia de Ribeirão Preto, Universidade de São Paulo, São Paulo, Brazil.*

Correspondence to: *Dr Rubens F. de Albuquerque Junior, Faculty of Dentistry, McGill University, Room M-60C, 3640 University Street, H3A 2B2 Motreal, QC, Canada. Email: rubens.albuquerque@mcgill.ca*

Materials and Methods

Ball attachments (Ball Anchor, Straumann) were examined exclusively in this study. The patrix attachments were made of titanium, and the matrix attachments were composed of gold alloy caps (Elitor).

One hundred forty-four components were retrieved from 36 patients and were divided into three groups according to the median period of wear: A (12 months), B (41 months), and C (96 months). Twenty new attachment components were added as controls. The used attachments were obtained from patients wearing mandibular complete overdenture prostheses retained by two implants placed in the interforaminal region and opposed by conventional complete dentures in the maxilla. New and used components were evaluated with a scanning electron microscope. An energy dispersive spectrometer was employed to determine the composition of the wear particles.

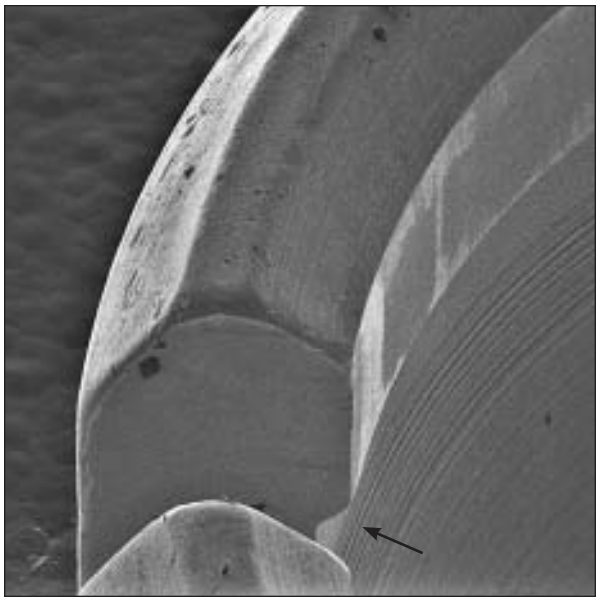

Fig 1a Micrograph of a new matrix (control) showing the thickening located at the edge of the internal part of the lamellae *(arrow)* (original magnification ×100).

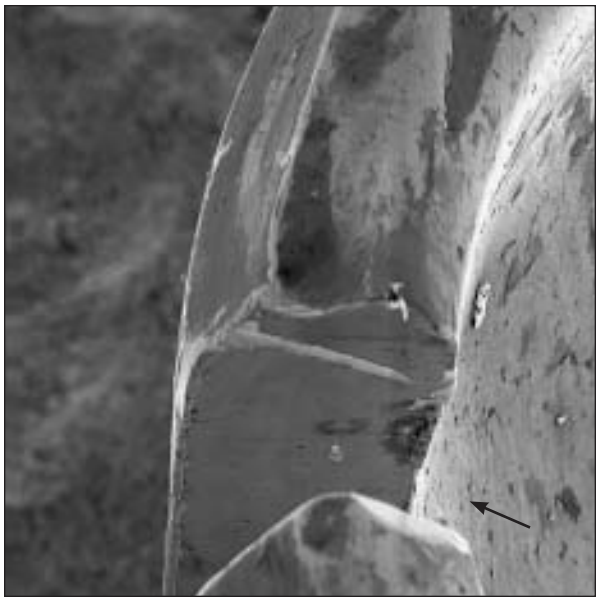

Fig 1b After 1 year of clinical use, note the disappearance of the thickening *(arrow)* (original magnification ×100).

Results

In comparison to the new components, observations of the worn matrices and patrices from group A revealed some scratch or score traces and the disappearance of machining grooves from the mating surfaces. From the matrix, the thick band at the internal edge of the lamellae, designed to ensure patrix retention, had disappeared almost completely (Figs 1a and 1b). Slight traces of scratching at the patrix equator were observed without any visible change to the ball shape. Scratches resulting from friction with the matrix lamellae appeared to be partly filled with metallic debris torn from the gold matrix (Fig 2).

Among the used matrices in group B, the edges of the lamellae were blunted and deformed along their entire length. Among the corresponding male parts, a slightly deformed profile with flattened zones or localized abrasions with scratches and scores were observed around the equator (Fig 3) and sometimes at the summit. Several shiny deposits of gold alloy were found on a rather evenly worn or deformed surface.

In more than three quarters of the matrices of group C, an amplification of the matting of the internal surface was noticed and sometimes led to welding of the lamellae. Some of the samples presented fatigue cracks or fractures of the lamellae. Wear particles were composed primarily of gold alloy, but small titanium debris was also found. Most of the patrices were deformed and off-center (Fig 4), with scoring parallel to the axis of insertion that was thickly sown with flakes of matrix material.

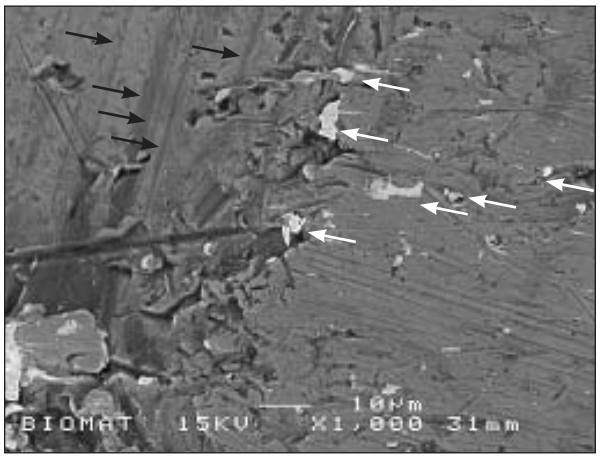

Fig 2 Patrix worn for 1 year. Magnification of the equatorial zone showed the border between a nonfunctional area with parallel machining grooves *(black arrows)* and a frictional area with scratches, scores, and surface modifications with gold flakes *(white arrows)* spread on the titanium surface (original magnification ×1,000).

Discussion

On the respective areas involved with the friction between the tip of the retentive lamellae on the equatorial surface of the patrix, wear was characterized essentially by abrasion.[5] With clinical use, wear leads to loss of metallic particles from the matrix and patrix, as well as the displacement of material by plastic deformation from both surfaces that slide across each other under pressure.

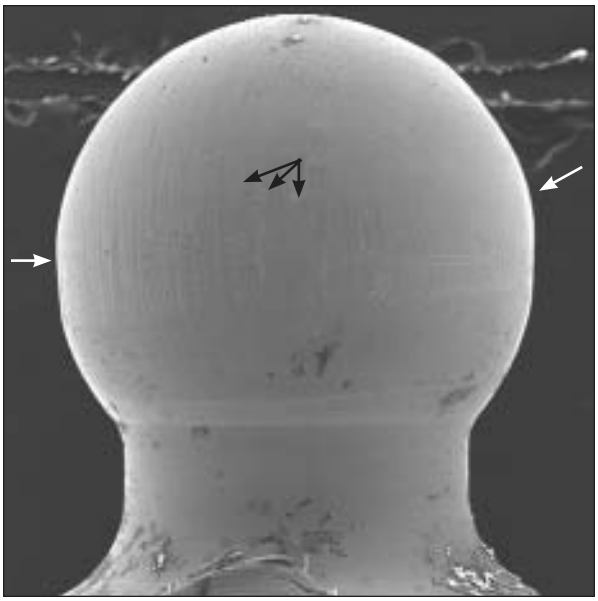

Fig 3 Lateral view of a patrix worn for 32 months (original magnification ×30). Note the oriented scratches *(black arrows)* and flattening of the equatorial zone *(white arrows)*.

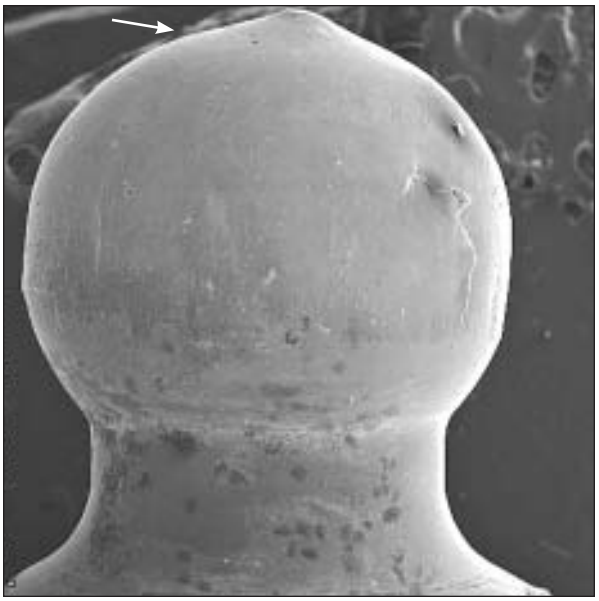

Fig 4 Worn ball attachment after 96 months of clinical use (original magnification ×30). The top of the ball was notably decentered and deformed as a result of plastic deformation and wear *(arrow)*.

The surface consequences of long-term use of the selected attachments include modifications of the shape of the male and female components that could be incompatible with the precision need for durable retention. The gold matrix appears to be the most vulnerable component via a rapid loss of material that is visible after 1 year of clinical use. However, dentists should also pay attention to the patrix component's shape and integrity over longer periods of wear. An obvious limitation of this study is the lack of correlation between the time-dependent component changes and documented patient perceptions of the retentive effectiveness of the changed components.

Conclusions

After 1 year, there was limited wear of the titanium patrices studied. Concerning the gold matrices, there was wear of the internal edge of the matrix. For a median period of 3.5 and an additional 8 years of clinical use, both male and female components show marked signs of abrasion. In addition to abrasive wear, plastic deformation occurred in the matching areas, leading to modifications of the shape of both components. A small amount of titanium was found in the gold alloy of the matrix, and a large amount of gold alloy was spread at the surface alterations of the titanium patrix. It would be interesting to find out if these changes materially affected patient perceptions of prosthesis retention.

Acknowledgments

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