

Full Length Research Paper

Dual Component Removable Partial Denture shows improved patient practicality: An evidence based pilot study

Changbin Fan¹, Wings TY Loo², Barry Ho Sing Yeung³, Mary NB Cheung², Yun Luo¹, Baiyan Lou¹ and Min Wang^{1*}

¹Department of Prosthodontics, Hospital of Stomatology, University of Sichuan, Chengdu, P.R.China.

²Faculty of Dentistry, the University of Hong Kong, Hong Kong.

³Department of Microbiology, Immunology and Molecular Genetics, the University of California Los Angeles, USA.

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Dual Component Removable Partial Denture (DuCo RPD) is composed of a double base; lower and upper. The lower base, where the artificial teeth are attached, acts as a support and is in contact with the alveolar ridges and oral mucosa. Clasps are designed on the upper base, which acts towards the retention and stabilization of the denture. This study aims to compare the practicality and physiological changes between the use of DuCo RPD and Removable Partial Denture (RPD). Thirty-three cases of Kennedy class III patients were chosen to apply either DuCo RPD or RPD. Annual check-up was performed for three years to survey body weight, physical signs, facial symmetry, dental caries, alveolar bone density, periodontal status, teeth mobility, denture retention, stability, degree of comfort, efficiency of biting, and total serum protein in blood before and after wearing DuCo RPD. All these factors were compared with patients before and after wearing traditional RPD. Body weight, physical signs, facial symmetry, dental caries, alveolar bone density and periodontal status were not statistically different between the RPD and the DuCo RPD users. Bone resorption, teeth mobility and teeth loss of the RPD group were significantly higher ($p < 0.05$) than the DuCo RPD group. A major increase in retention and stability ($p < 0.05$) were also observed for the DuCo RPD group. Patients who wore DuCo RPD had a higher biting efficiency than patients who wore RPD ($p < 0.05$). DuCo RPD use is more practical and patients with DuCo RPD application showed better physiological outcomes than patients with RPD application.

Key words: Artificial teeth, alveolar ridges, biting efficiency, denture retention, denture stability, dual component removable partial denture.

INTRODUCTION

Oral health is always important for one's life. Mastication, a process of cutting and chewing food into small particles, is the first step of digestion achieved by teeth. Poor oral condition, however, can disrupt mastication. Edentulism, an example of poor oral condition caused mainly by periodontitis, and tooth decay etc, is a disease that leads to mastication deficiency. Missing teeth makes chewing more difficult, which in time results in food being over-

mixed with saliva. Consequently, the saliva floods the bolus (Prinz et al., 1997), separates the food particles, affects nutrients absorption and eventually leads to malnutrition (Musacchio et al., 2007; N'gom and Woda, 2002). As a result of that, missing teeth restoration is becoming popular. Nowadays, there are many methods to restore the loss of teeth such as inlays and outlays, dental implants, fixed or removal partial dentures, while each method has its own advantages and disadvantages. One of the most popular methods in the 1970s to restore the missing teeth include removable partial denture (RPD). However, it lost its favor since it was technically more difficult with cobalt/chrome alloys than gold. Also,

*Corresponding author. E-mail: wtyloo@gmail.com. Tel.: 86 28 61153338. Fax: 86 28 85582167.

RPD has been found not to be suitable for all people as studies do not recommend RPD for patients with mobile abutment teeth of I° to II° (Berg, 1985; Junwu, 1994; Soo and Leung, 1996), defined as first distinguishable sign of movement but not greater 1 mm. In order to allow a more variety of partial edentulous patients adapting to partial denture, Dual Component Removable Partial Denture (DuCo RPD) is newly designed based on RPD for partially edentulous patients who are not suited to use RPD.

DuCo RPD is composed of a double-layered base made of phosphate-bonded with chromium-cobalt alloy (Pienkos et al., 2007). The lower base makes contact with the artificial teeth, alveolar ridges and oral mucosa, serving as a support during mastication. The upper base consists of clasps that make contact with the abutment teeth, working towards the retention and stability of the denture. The double-layered base is interlocked by grooves. When functioning, only the lower base sinks due to occlusion. The stress due to occlusion is separated evenly in order to protect the abutment teeth. Thus DuCo RPD splits the two major functions of support and retention between the lower and upper base (Figure 1).

This randomized study is the first study involving DuCo RPD. It compares the practicality and physiological outcomes between the uses of DuCo RPD and RPD. Practicality is measured by denture retention, stability and comfort. Physiological factors are measured by body-weight, facial symmetry, dental caries, alveolar bone density, periodontal health, teeth mobility, teeth survival-andbitin-gefficiency.

MATERIAL AND METHODS

Patient sample characteristics

A total of 33 patients were randomly assigned to use either RPD or DuCo RPD (Table 1) between 2001 and 2006. The ethics committees at Sichuan University and College of Stomatology approved the research protocols (reference number: 2001-00-03), also informed consents were obtained from these patients before the joint study. All the patients met our inclusion criteria, as they all had Kennedy class III (unilateral bounded partially edentulous) dentition defects with at most two missing teeth in a row. The reduction of their alveolar bone was not more than a half root length. Periodontal diseases were under control and no patient was presented with aggressive periodontitis or suffered from systemic diseases such as diabetes mellitus or temporal mandibular joint disorder (TMJ).

Design and fabrication of the denture

All patients underwent an oral examination to choose two to four properly dispersed abutment teeth for the construction of either DuCo RPD or RPD according to predetermined patient randomization. The mobility of each abutment was recorded as mobile, or non-mobile. An impression for each abutment teeth was modelled (Macpherson and Evans, 1993; Tan and McKee, 1993) and then poured into stone models (Hill, 1977; Jackson and Butler, 1995). The lower base covered most of the periodontal tissue without affecting natural oral functions. The clasp and rest of the upper base were distributed evenly for a favourable retention and stability.

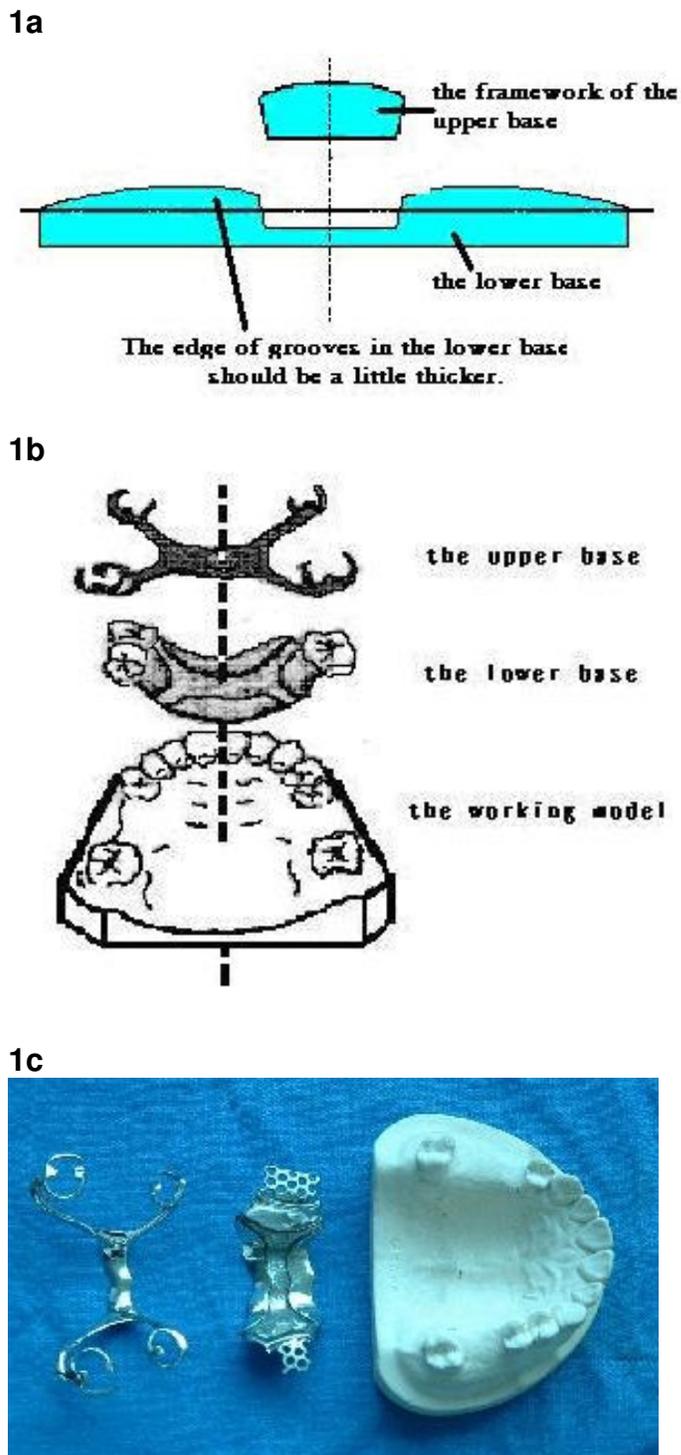


Figure 1a, b and c. Upper base (left), lower base (middle) and working model of the Dual Component Removable Partial Denture (DuCo RPD). The Figure 1a is side-view of denture design, 1b shows the graphic design of the denture. The 1c is a real make denture. Notice the interlocking grooves on the lower base which allows and intimate connection to the mouth and the upper base. The lower base makes contact with the artificial teeth, alveolar ridges and oral mucosa, serving as a support during mastication. The upper base consists of clasps that make contact with the abutment teeth, working towards the retention and stability of the denture.

Table 1. Baseline data of Dual Component Removable Partial Denture (DuCo RPD) and Removable Partial Denture (RPD) users.

Parameter	SRPDa	RPD
Range (mean)	30-72 (52)	29-69 (51)
Gender M/F	9/6	11/7
# of teeth	56	63
Mobile teeth	18	22
Patients	15	18
Non-mobile teeth	38	41

The cast for the lower and upper base were then duplicated as a phosphate-bonded cast in wax casting (Jacob, 1992). After achieving a proper fit, the chromium-cobalt alloy base denture was made (Figure 2).

Patient follow-up

Check-ups were performed annually for three years at our clinic. Several factors were monitored either by direct examination or through conducting questionnaire. Dental caries and alveolar bone density were measured by panoramic dental x-ray (Shimadzu Digital X-ray, Shimadzu Corporation, Japan). Other parameters that were being monitored include body weight, facial symmetry, periodontal health, teeth mobility, denture retention, denture stability, degree of comfort.

Biting efficiency

5.0 g of peanuts were put into patients' mouths for them to chew for 30 s. The number of bites was recorded. Then, the bolus inside the mouth and denture were disgorged, washed and then poured into a 1000 ml measuring cylinder. Water was added to dilute the extract to 1000 ml. Suspension was mixed for 1 min and stayed for 2 min. Using graduation pipette, 1/3 of the suspension was transferred into a cell. The cell was then measured by LS-722N Spectrophotometer (Shanghai, China) at absorbance of 590 μm . Chewing efficiency was measured before, and after wearing DuCo RPD for 6, 18 and 36 months.

Total serum protein inside blood

The clotted peripheral blood was collected from all patients in both groups (patients who wore DuCo RPD or RPD) after 6, 18 and 36 months. The serum was then withdrawn from the clotted blood and was tested in a closed system by protein assay machine (COBAS, INTEFRA-400, Roche, Germany) for serum proteins.

Statistical analysis

Statistical analysis was performed using an analysis of variance (one-way ANOVA) and student's t-test of SPSS-15 (USA). The acceptance level of significance was $p < 0.05$.

RESULTS

The patients' body weight, facial symmetry, dental caries and periodontal health were not statistically different between the RPD and the DuCo RPD users. When com-

2a



2b



Figure 2a and b. Application of the Dual Component Removable Partial Denture (DuCo RPD). The denture was fixed using the teeth adjacent to the edentulous space as abutments.

pared with DuCo RPD group, patients who wore RPD had a significantly lower alveolar bone density, and higher teeth mobility and tooth loss rate ($p < 0.05$). A statistically significant difference was also observed between the DuCo RPD and the RPD group in terms of retention and stability ($p < 0.05$) (Tables 2 and 3). For the two experiments testing on chewing efficiency, before wearing DuCo RPD, the optical density (OD) was lower than that of the control group ($p < 0.05$) (Table 2). Moreover, the more tooth loss, the lower the chewing efficiency ($p < 0.05$). After wearing DuCo RPD or RPD, both results showed an increase in OD and a higher OD values were measured for wearing dentures for a longer period ($p < 0.05$). Patients who wore DuCo RPD had a greater OD values than patients who wore RPD ($p < 0.05$) (Table 2). The average total serum protein level before wearing partial denture was lower than the normal range (Table 3). After wearing partial denture, both groups showed an increase in total serum protein level while patients who

Table 2. Mean values of optical density and p values for two groups of patients who wore DuCo RPD or RPD at definite time periods.

Group	Mean OD Of DuCo RPD	Mean OD of RPD	p values
Control	1.138+/-0.24		
Before wear	0.7225+/-0.185	0.708+/-0.076	0.87
Partial Denture			
Wear 6 months	1.09+/-0.0195	0.866+/-0.025	0.014*
Wear 18 months	1.52+/-0.0665	0.7765+/-0.0315	0.005*
Wear 36 months	1.61+/-0.047	0.9075+/-0.0155	0.004*

p<0.05 showed statistical significant between DuCoRPD and RPD group (+/- number): Data are presented as mean±95% confidence interval (95% CI).

Table 3. Mean total serum protein and p values for two groups of patients who wore DuCo RPD or RPD.

Group	Mean total serum protein of DuCo RPD	Mean total serum protein of RPD	p values
Before wear	63.9+/-2.8	58.3+/-2.3	0.57
Partial Denture			
Wear 6 months	65.8+/-1.73	63.1+/-1.36	0.19*
Wear 18 months	78.8+/-5.1	69.25+/-4.5	0.011*
Wear 36 months	86.75+/-2.8	77.8+/-4.4	0.047*

Normal range of serum total protein: 66-87g/L.

p<0.05 showed statistical significant between DuCoRPD and RPD group (+/- number): Data are presented as mean±95% confidence interval (95% CI).

wore DuCo RPD had a higher increment that patients who wore-RDP (P<0.05).

DISCUSSION

Oral health is highly related with one's quality of life, especially among the elderly (De Visschere and Vanobbergen, 2006; Gomes et al., 2006; Jagger et al., 2006; Koshino et al., 2006; Tsakos et al., 2006). Having good oral health can improve the efficiency of nutrients absorption and can prevent the risk of developing nutrition-induced diseases (N'gom and Woda, 2002). Among the teeth restoration methods, removable dentures were the main prosthetic therapy for elderly patients (Chen et al., 2004). Conventional RPD is divided into three types: tooth-supported denture, tissue-supported denture and tooth-tissue-supported denture (Berg, 1985), each with its own advantages and disadvantages.

Tooth-supported dentures have sound functions of retention and stability, as the clasps (Lubovich and Peterson, 1977; Moghadam, 1990) on the abutment teeth serve as a direct retainer. However, the stresses of mastication are mainly supported by the abutment teeth (Burns and Unger, 1994; Hansen and Russell, 1994) thus increasing the risk of abutment damage. This denture is not suitable for patients with mobile abutments of I° or II°.

Tissue-supported dentures, on the other hand, have no occlusion rests to support. Although it is adapted for patients with multiple missing teeth (Kerschbaum, 1977) or mobile abutments of I° to II° (Amarasena et al., 2003), the functions of retention of in this type of denture is rather poor. It is easy for patients to create axis and side movements during mastication (Ben-Ur et al., 1988), which may enhance the destruction of abutments.

The design of the DuCo RPD includes the merits of sound retention from teeth-supported RPD and minimal abutment damage from tissue-supported RPD by utilizing an interlocking two-layered base.

DuCo RPD is favourable for the health and stability of abutment teeth and periodontal tissue, especially the abutments with of mobility I° to II° (Kawazu and Sudo, 2001; Li and G, 2006). This design enlarges the choice of abutments. In particular, DuCo RPD is advantageous to the patients with multiple missing teeth or poor abutment conditions, which may lead to dissatisfactory retention and stability with the use of traditional RPD (Chee and Jivraj, 2006).

DuCo RPD users in our study demonstrated increased practicality over RPD users based on the questionnaire which measured retention, stability and comfort. Both retention and stability parameters were significantly greater than those of the RPD users (p < 0.05). The improved retention and stability of DuCo RPD will pose

less of a hindrance to denture users during the daily activities. The levels of comfort between the two groups of users were not significantly different.

Physiological factors of DuCo RPD users had either similar or shown improvement to the traditional RPD. SRPD did not lead to negative effects in body weight, physical signs, facial symmetry, dental caries or periodontal health, as these factors were not significantly different than those of the RPD users. Furthermore, DuCo RPD users demonstrated significant improvement in terms of alveolar bone density, teeth mobility and teeth loss as compared with RPD users ($p < 0.05$). Less bone resorption with DuCo RPD use may prolong long-term oral health of its users. Less conversion of non-motile teeth to motile teeth, or motile teeth to the loss of teeth will have less negative effects on the lifestyle of the patient. Moreover, DuCo RPD users showed an improvement in biting efficiency. Although it was not as efficient as the normal group, still, it was much better than patients who wore traditional RPD ($p < 0.05$). With a better biting efficiency, absorption of nutrients will be more effective as food particles are more accessible for saliva and hence, food can be better broken down and absorbed. As a result of that, patients who wore DuCo RPD had a higher serum level than patients who wore traditional RPD.

This is the first study to compare multiple parameters between users of DuCo RPD and the traditional RPD. We demonstrated that DuCo RPD used is more practical and demonstrate better physiological outcomes than RPD for patients. A phase I clinical trial will be conducted in the future of DuCo RPD

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