CHAPTER 1

INTRODUCTION

PRINCIPLE, THEORY, RATIONALE, AND / OR HYPOTHESIS

The magnets have been used over the past several years for various purposes. They have been incorporated into medical reconstructive therapies. In dentistry, they have been used since 1960s, most commonly to aid the attachment of dentures, overdentures (Gillings, 1981; 1983), and maxillofacial prostheses (Javid, 1971).

Originally, the magnets used in dentistry were made of either Aluminium-Nickel-Cobalt (AlNiCo) or Platinum-Cobalt (Pt-Co) alloys. However, the applications are largely limited because of the large size of magnets required to give adequate retentive force.

The rare earth magnets made of samarium-cobalt and neodymium-iron-boron were developed and put to practical use as new magnets because their properties were superior to previous conventional alloys. They could be manufactured in smaller sizes without losing force. In addition, the other excellent magnetic properties are high peak energy products and coercive forces (Blechman, 1985). However, they have some shortcomings, such as brittleness, low corrosion resistance, irreversible magnetic loss when heated (Tsutsui *et al.*, 1979), and expensiveness.

The magnetic alloys have recently been introduced as an alternative to traditional orthodontic appliances. They were successfully used in orthodontic force systems for allowing optimal physiological tooth movement, expansion, fixed retention, correcting the anterior openbite, and for serving as an active component of the functional appliances (Blechman, 1985; Dellinger, 1986; Sandler *et al.*, 1989; Vardimon *et al.*, 1989; 1990; Springate and Sandler, 1991; Bondemark and Kurol, 1992; Darendeliler and Joho, 1992; 1993; Darendeliler and Friedli, 1994).

The force generated and the composition of the available commercial magnets have been investigated (Watanakit and Jotikasthira, 2001). They found that the commercial magnets could generate the attracting force to orthodontic brackets greater than that generated by orthodontic magnets with equal volume. Moreover, the compositions of commercial magnets and orthodontic magnets were comparable. Hence, these commercial magnets can provide marked advantages for clinical applications, particularly for orthodontic treatment.

Prior to clinical trials of these magnets, it seems considerably important to investigate their biological aspects, mechanical properties, workability, and resistance to tarnish and corrosion. Ideally, the magnets need to have high corrosion resistance and to be innocuous to host cells and tissues.

The biological effect of magnets has been considered either in terms of the material itself or the magnetic field. Some studies have shown that these magnets have acceptable biocompatibility (Camilleri and McDonald, 1993), but others have demonstrated possible cytotoxic effect (Linder-Aronson *et al.*, 1992; 1995; 1996). Furthermore, there were several reports showing the release of corrosion products (Tsutsui *et al.*, 1979; Vardimon and Mueller, 1985; Bondemark *et al.*, 1994a; b).

The susceptibility to corrosion is of great clinical importance for this project. The reason is that there may be risks of disturbed physical properties and any deleterious biological effects to host cells. With several lines of evidence regarding the biological effects, the use of dental magnets should be limited until the safety can be assured. Therefore, this study assessed the commercial and orthodontic magnets by means of the composition and quantity of corrosion products released from both magnets, and the biological effect of these corrosion products on viability and growth of the cultured human gingival fibroblasts. The findings of this *in vitro* study may be useful to better understand the biological effects of these magnets for the complex *in vivo* phenomena in the oral cavity.

THE OBJECTIVES OF THE STUDY

1. To determine the composition and quantity of corrosion products released from orthodontic magnets and commercial magnets immersed in cell culture medium, 0.9% sodium chloride, or artificial saliva for 7 days.

2. To investigate and compare the effects of corrosion products of orthodontic magnets and commercial magnets on the viability of the cultured human gingival fibroblasts for 3 and 7 days.

3. To investigate and compare the effects of corrosion products of orthodontic magnets and commercial magnets on the growth of the cultured human gingival fibroblasts for 3 and 7 days.

THE HYPOTHESES

The null hypotheses, Ho, are:

1) "The effect of corrosion products released from orthodontic magnets and commercial magnets on the viability of the cultured human gingival fibroblasts at each time point is not significantly different from that of the control group."

The hypothesis will be rejected if there are significant differences between the viability of the cultured human gingival fibroblasts in the presence of corrosion products and the control group.

2) "The effect of corrosion products released from commercial magnets and orthodontic magnets on the growth of the cultured human gingival fibroblasts at each time point is not significantly different from that of the control group."

The hypothesis will be rejected if there are significant differences between the growth of the cultured human gingival fibroblasts in the presence of corrosion products and the control group.

ANTICIPATED BENEFITS

1. To understand the composition of corrosion products released from orthodontic magnets and commercial magnets.

2. To investigate the cellular responses to corrosion products released from magnets. The *in vitro* study of biological effect of magnets on the host cells will be useful for future research in clinical application of the magnet in orthodontics.

3. To gain basic knowledge in order to select available commercial magnets for future use in the field of orthodontics.

SCOPE OF THE STUDY

The biological effect of magnetic materials had been questioned. Consequently, we would like to address the question with 2 specific aims. These included (1) to reveal and compare the composition and quantities of six elements (boron, cobalt, copper, iron, nickel, and silicon) in corrosion products released from orthodontic magnets and commercial magnets in three different types of solution (cell culture medium, 0.9% sodium chloride, and artificial saliva) and (2) to investigate the effect of corrosion products from these two types of magnet on the viability and growth of the cultured human gingival fibroblasts.