Properties of Super Stainless Steels for Orthodontic Applications

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INTRODUCTION

Various kinds of orthodontic appliances and materials have been developed for ideal tooth movement during orthodontic treatment. The orthodontic appliances made of metal are band, arch wires, bracket, and miniscrew as orthodontic anchorage. Generally, materials of these appliances are stainless steels, Co-Cr, Ni-Ti and Ti alloys with the proper biocompatibility. However, their localized corrosion can frequently occur in an oral cavity or human body. Super stainless steel, recently developed, has very high corrosion resistance due to the enhanced passive film by the synergistic effect of nitrogen and molybdenum. Super stainless steel has higher corrosion resistance than conventional stainless steel and has higher mechanical properties and formability than titanium and its alloys. The purpose of this study was to evaluate and compare microhardness, nickel ion release, corrosion resistance, and the cytotoxicity of 4 types of super stainless steels and 316L stainless steel as the control group according to nickel contents, and to determine the acceptability as the new material for various kinds of orthodontic appliances.

EXPERIMENTAL

The phase fraction, chemical compositions and microhardness were performed and corrosion resistance and nickel ion release amount was evaluated using anodic polarization test and graphite furnace atomic absorption spectroscope at 37℃ in artificial saliva and cytotoxicity was estimated by agar overlay test for the specimens presented in Table I.

Table I. Compositions of various stainless steels(wt%)

Specimens	Cr	Ni	Mo	W	N
SR-50A	23.19	20.97	6.56	-	0.25
316L S.S.	17.94	12.21	3.18	-	-
SR-6DX	26.51	7.65	2.41	3.18	0.25
SFSS	28.01	2.89	2.91	8.58	-
SR-3Mo	15.12	1.53	5.01	-	0.10

RESULTS AND DISCUSSION

Super stainless steels showed higher microhardness than 316L stainless steel and super martensitic stainless steel (SR-3Mo) showed the highest microhardness(Table II). In anodic polarization curves(Fig. 1), corrosion resistance was high in order of SR-50A, SFSS, SR-6DX, 316L S. S., SR-3Mo. There was no increase in nickel ion release amount from SR-50A, SR-6DX, 316L S. S. with immersion time in artificial saliva, whereas there was some increase from SFSS and SR-3Mo according to immersion time as presented in Fig. 2. All super stainless steels showed very low cytotoxicity regardless to nickel contents, although SR-3Mo showed relatively higher cytotoxicity as presented in Table III.

It is concluded that SR-50A among super stainless steels has the highest corrosion resistance and biocompatibility, so it is desirable to use as the new material for various kinds of orthodontic appliance.

Table II. Hardness values(Hv) of various stainless steels

SR-50A	316L S.S.	SR-6DX	SFSS	SR-3Mo
268.80	227.08	309.60	263.02	646.42
±16.02	±6.05	±4.52	±6.16	±8.07

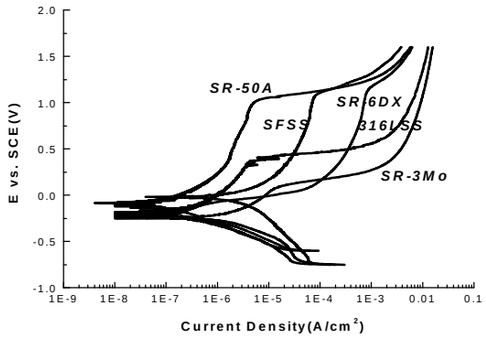

Fig. 1. Anodic polarization curves of various stainless steels in artificial saliva.

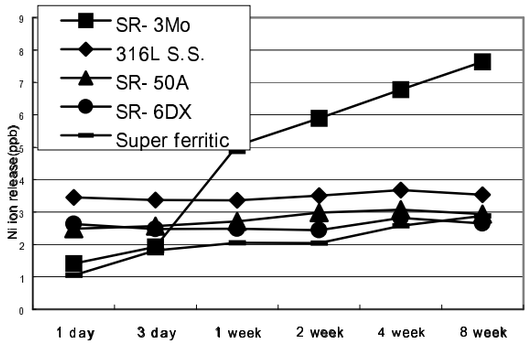

Fig. 2. Nickel ion release amount from stainless steels.

Table III. Cytotoxicity of various stainless steels.

Specimen	Response Index	Cytotoxicity
SR-50A	0/0	none(-)
316L S.S.	0/1	mild
SR-6DX	0/0	none(-)
SFSS	0/1	mild
SR-3Mo	1/2	mild(+)
Positive(NPG)	2/4	moderate(++)
Negative(Polyethylene)	0/0	none(-)

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