SHORT COMMUNICATION

O-20. STUDY OF CORROSION AND WEAR OF SURGICAL INSTRUMENTS DURING STERILIZATION

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Key Words
ligature-cutting pliers, sterilization, corrosion, wear, electrochemical study.

Introduction
Since patients' precise infectious risk remains unknown, it is a standard procedure to sterilize all surgical instruments before each care or intervention. Sterilization processes including prion inactivation and viruses destruction are quite intensive and may cause damages to these instruments (Figure 1, Figure 2). The aim of this work is to assess the effect of sterilization on orthodontic ligature-cutting pliers used under close clinical conditions, and more specifically to evaluate the corrosion and wear of the pliers' cutting edges.

Materials and Methods
Material included one set of 25 ligature-cutting pliers supplied by three major orthodontic distributors (Dentaurum®, ETM® and RMO®), .010 inch stainless steel orthodontic ligature wire and five disinfecting agents (Ampholysine Plus®, Elusept®, Dy Septi®, Prédolyse®, Dentasept Ultra®). Pliers (chemical composition, Vickers hardness, crystalline network) and disinfecting agents (chemical composition, pH) were initially characterized. Corrosion susceptibility of each constituent part of the different pliers was then evaluated, and galvanic coupling performed. Electrochemical behaviors of the whole pliers were studied by immersion in the various disinfecting agents diluted with demineralized water. Pliers' corrosion and wear were also assessed with numerical magnifying glass as a function of incremental sterilization cycles.

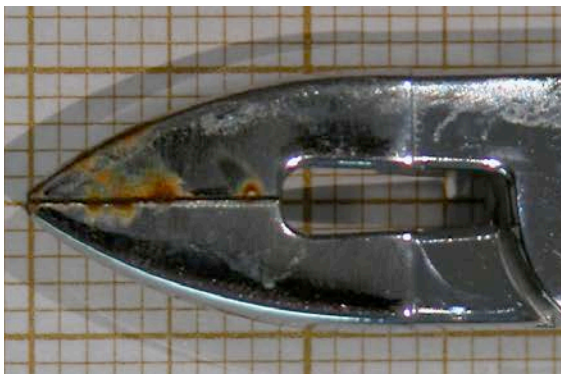


Figure 1 : View of a ligature-cutting plier after 20 sterilization cycles (optical microscope x50)

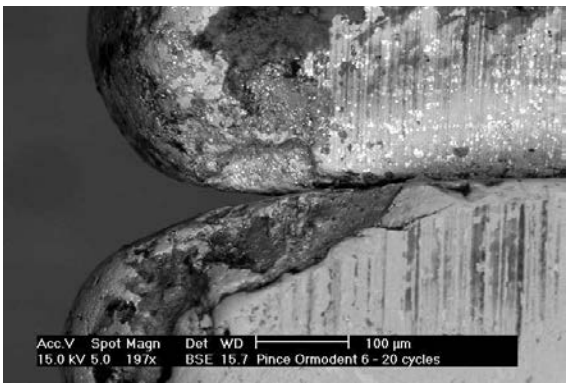
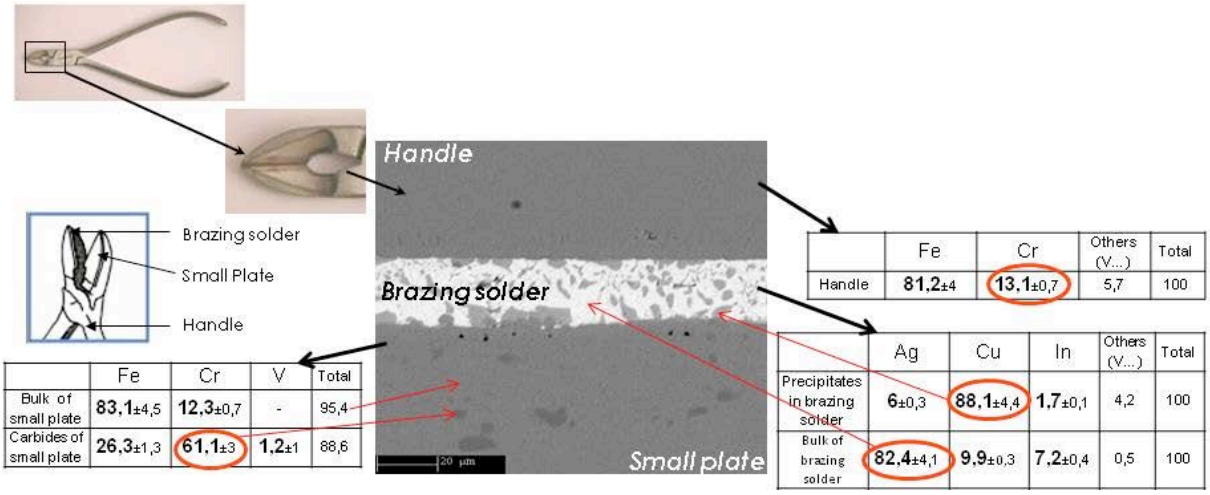


Figure 2: View of one plier's cutting edges after 20 repeated sterilization cycles (scanning electron microscope x200)

Results

The pliers' handles are made of stainless steel containing about 13-14% of chromium but no nickel. Cutting edges are made of small plates welded to the short arms of the pliers. These plates include for the ETM® pliers, tungsten and vanadium carbides, while Dentaurum® and RMO®'s pliers' cutting edges contain chromium carbides (Figure 3).

A small layer of pure chromium surrounds the ETM® pliers, layer that may be broken down with repeated sterilization cycles. Most disinfecting agents are composed of quaternary ammoniums (which combine a detergent effect and a disinfecting action) except one product whose action is restricted to disinfection. Electrochemical behavior (corrosion potential : corresponds to corrosion susceptibility, polarization resistance : corresponds to kinetics of corrosion) of each constituent part of the pliers was followed during a period of 12 hours and showed that brazed small plates are less resistant to corrosion than welds. However, these behaviors are not depending on disinfecting agents diluted with demineralized water. Electrochemical behaviors of the pliers taken as a whole were also studied by immersion in the different disinfecting agents and showed no particular differences regarding these disinfecting agents. The resistance to corrosion and wear of the pliers' cutting edges after sectioning 20 ligatures followed by sterilization cycles, was found to be satisfactory whatever the disinfecting agent was.



	Fe	Cr	V	Total
Bulk of small plate	83,1±4,5	12,3±0,7	-	95,4
Carbides of small plate	26,3±1,3	61,1±3	1,2±1	88,6

	Fe	Cr	Others (V...)	Total
Handle	81,2±4	13,1±0,7	5,7	100

	Ag	Cu	In	Others (V...)	Total
Precipitates in brazing solder	6±0,3	88,1±4,4	1,7±0,1	4,2	100
Bulk of brazing solder	82,4±4,1	9,9±0,3	7,2±0,4	0,5	100

Figure 3 : Dentaurum® plier composition

Discussion

All the experiments were run with demineralized water, in order first to avoid changes in composition of the water used to dilute the disinfecting agents and second to get rid of chlorides which are found in tap water. These chlorides may indeed cause corrosion as shown in Figures 4 & 5.

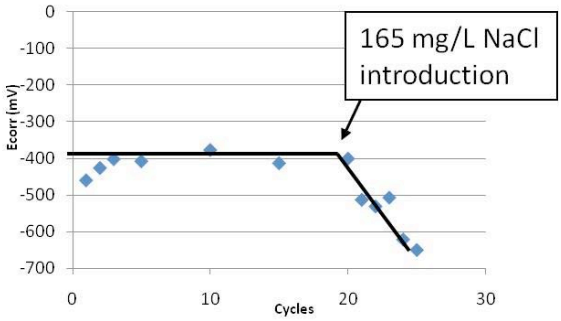


Figure 4 : Variations of corrosion potential (Ecorr) with increasing number of cycles

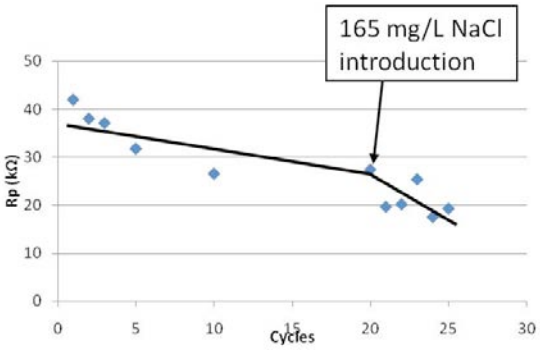


Figure 5 : Variations of polarization resistance (Rp) with increasing number of cycles

Conclusion

Ligature cutting pliers display various characteristics while their electrochemical behaviors remain very close. Disinfecting agents possess similar properties, and do not tend to be very aggressive toward pliers, provided first that sterilization procedures are strictly respected, and second that demineralized water is used to dilute the disinfecting agents.

Acknowledgements

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References

1. Ministère de la Santé et des Solidarités, Direction Générale de la Santé (2006), 72p.

2. VENDRELL R.J. et al. (2002), American Journal of Orthodontics and Dentofacial Orthopedics, 121 (5), 467-471.

3. WHO (1999), 38p.