

## DISINFECTION OF ORTHODONTIC PLIERS USING THREE DIFFERENT DISINFECTANTS

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### Abstract

In orthodontics effective disinfection of pliers in short time is important. We aimed to evaluate the effectiveness of three disinfectant solutions (two quaternary ammonium compounds (Deconex, Micro10+) and one hydrogen peroxide disinfectant (Sanosil)) in orthodontic pliers' disinfection.

Nine Adams pliers were sterilized with autoclave. Pliers were contaminated with standard and hospital staphylococcus aureus and pseudomonas aeruginosa. After rinsing, pliers were immersed in assigned disinfectants. Immersion times were at 5, 10, and 15 min. Pliers were rinsed and shaken in sterile physiologic serum to bacteria elimination. Neither negative control group was submitted to disinfection process, nor positive control to any contamination processes. Samples were transferred to culture medium and colony count was done after 24 hours incubation.

Culture results of positive control group were negative while in the negative control large number of colonies was appeared. Regardless type of bacteria, in 5 and 10 min effective decontamination order was: Sanosil>Deconex>Micro10+. In 15 min, results of three disinfectants were not significantly different.

All disinfectants reduced bacteria significantly, even with 5min immersion. Antimicrobial activity was elevated by increasing exposure time. The disinfectant containing hydrogen peroxide and silver ion (Sanosil) showed greater activity than QACs (Micro10+ and Deconex).

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### Introduction

Due to prevalence of blood-borne diseases, infection control became one of the main concerns for dental health workers. Infection control is necessary to prevent cross contamination among patients and dental

personnel.<sup>1-6</sup> Orthodontists may be exposed to blood in the patient's mouth of ten times a week on average. Therefore, orthodontics may not be considered as a low risk dental practice.<sup>7</sup>

In addition, it has been shown that orthodontists, compared to other dental specialists have fewer trends to follow infection control guidelines.<sup>2, 7</sup> The reason may be due to the relatively large number of patients in an orthodontic office.<sup>7-9</sup> It has been shown that, on average, an orthodontist has 2.5 times more patients than a dentist.<sup>7</sup> In each orthodontic appointment, visit time is short and multiple pliers are used. Orthodontic pliers are various and expensive, so in each office there are limited number of each.

According CDC guidelines, infection control should be observed for each patient.<sup>1, 4, 6</sup> In dentistry semi-critical and noncritical devices

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should be disinfected between patient's intervals.<sup>3,5</sup> Orthodontic pliers are semi-critical devices. The main justification of professionals who are not meticulous in infection control is that it is a long and time consuming procedure.<sup>8, 10</sup> Considering high turnover rate of patients in an orthodontic office, pliers' disinfection in a short time has a remarkable importance. According to Almeida *et al.* and Angelillo *et al.* glutaraldehyde is effective for plier disinfection.<sup>8, 11</sup> Unpleasant odor and staining are some of disadvantages of glutaraldehyde.

When a new disinfectant is offered in the market, the performance should be tested by unbiased academic studies. Sanosil, Micro10<sup>+</sup> and Deconex are some of disinfectant solutions available in the market. Sanosil is a product of new disinfectant generation and consisted of hydrogen peroxide and too small amounts of silver ion. Hydrogen peroxide and silver have synergistic effect and it's complex is a high level disinfectant.<sup>5, 12</sup> Micro10<sup>+</sup> and Deconex are from new generations of QAC (quaternary ammonium compounds). They have quaternary ammonium and alcohol basis as effective materials.

For highest effectiveness of disinfectants each of the manufacturer's suggested specific concentrations and times. In current study, we therefore aimed to evaluate efficiency of three disinfectant solutions (Sanosil, Micro10<sup>+</sup>, Deconex) on disinfecting orthodontic pliers to introduce most effective solution with shortest contact time.

### Materials and Methods:

In this study, the effectiveness of three disinfectant solutions used in every day practice was assessed. The research protocol was approved by the Research Committee of the Mashhad University of Medical Sciences in Mashhad, Iran. Nine newly purchased sterile stainless steel Adams orthodontic pliers from same brand (Dentaurum, Germany) were contaminated *in vitro* with bacteria including: standard staphylococcus aureus (ATCC 25923), hospital staphylococcus aureus, standard pseudomonas aeruginosa (ATCC 27853) and hospital pseudomonas aeruginosa.

The contaminated pliers randomly divided to three groups and received disinfection treatment in three groups as follows:

1- Pliers immersed in Micro10

(Unident, Switzerland) for 5, 10, and 15min.

2-Pliers immersed in Deconex 53plus 2% (BORER CHEMIE, Switzerland) for 5, 10, and 15 min.

3-Pliers immersed in Sanosil D2 2% (Sanosil Ltd., Switzerland) for 5, 10, and 15 min.

For bacteria suspension preparation, after initial culture on blood agar culture medium, a colony was transferred to second blood agar medium and cultured. Bacterial colonies were incubated for 12 hours and grown colonies were suspended in sterile physiologic serum. Bacterial colonies were gradually added to the suspension so that the suspension opacity reached to equal as 0.5 McFarland standard. The 0.5 McFarland standard provides an optical density comparable to the density of a bacteria suspension of  $1.5 \times 10^8$  colony forming units (CFU)/mL. Plier contamination was performed in maximally 15 min after suspension preparation. Initially orthodontic pliers were sterilized with autoclave at 121°C for 15min. Bacteria contamination was performed using 250 ml of assigned suspension and pliers were immersed for 3-5 min. In order to simulate actual clinical conditions after contamination, each plier was rinsed for 30 seconds with tap water without using brush. Pliers were then put on a sterile towel for drying.

Following that, pliers were transferred into the related disinfectant solution (Micro10<sup>+</sup>, Deconex, Sanosil) and immersed. Three immersion times were considered: 5 min, 10 min, and 15 min. In each group after assigned immersion period, pliers were removed and washed with tap water.

In next step each plier was shaken in 10ml of sterile physiologic serum to elimination and suspension of bacteria. 100µl of this suspension was transferred and spread on blood agar EMB agar culture medium in petri plates.

In negative control group pliers were immersed in physiologic serum instead of disinfectant solution. In positive control group, after sterilization with autoclave, pliers without exposure to bacteria suspension were immersed and shaken in physiologic serum. 100µl of this serum was transferred to culture medium.

Culture mediums were incubated for 24 hours at 37°C and grown colonies were counted. Colony count was repeated three times for each bacteria.

After the data collection, SPSS software version15 (SPSS Inc., Chicago, IL, USA) was

used for analysis. Statistical analysis was performed by using Kruskal–Wallis analysis. In this study  $p < 0.05$  was considered as significant.

## Results:

There was not any bacterial colony in the culture of positive control groups. Culture results of negative control samples are illustrated in Table 1.

	Standard SA <sup>a</sup>	Hospital SA <sup>a</sup>	Standard PA <sup>b</sup>	Hospital PA <sup>b</sup>
Mean±S.D.	579 ± 6.245	149 ± 2	743 ± 4.358	124 ± 5.033

<sup>a</sup> staphylococcus aureus

<sup>b</sup> pseudomonas aeruginosa

**Table 1.** Colony count results of negative control group.

Table 2 shows the detailed results of the effect of different disinfectants at different exposure times regardless of the type of bacteria. In addition, regardless of the type of bacteria in 5 min and 10 min exposure times, the order of effective decontamination was: Sanosil > Deconex > Micro10<sup>+</sup> and in 15 min exposure time Sanosil, Deconex and Micro10<sup>+</sup> had not statistically significant differences ( $p < 0.05$ ).

Disinfectant	Contact time		
	5min	10min	15min
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.
Sanosil	12.83 ± 16.44	1.83 ± 3.24	0.83 ± 1.69
Deconex	17.33 ± 15.9	5.75 ± 9.43	1.91 ± 2.64
Miro10 <sup>+</sup>	19.25 ± 14.44	7.91 ± 7.95	1.66 ± 2.05
Total	13.13 ± 14.57	5.16 ± 7.59	1.47 ± 2.15
	$\chi^2 = 6.073$ P = 0.048	$\chi^2 = 6.078$ P = 0.048	$\chi^2 = 1.975$ P = 0.372

**Table 2.** Comparison colony counts according disinfectant types and contact times regardless kinds of bacteria.

Significant differences were observed in colony count between negative control group and tests groups ( $p < 0.05$ ).

The effective decontamination order of different disinfectants on hospital staphylococcus aureus at 5 min, 10 min and 15 min was as: Sanosil > Deconex > Micro10<sup>+</sup> and on hospital pseudomonas aeruginosa at all three study times was as Sanosil = Deconex > Micro10<sup>+</sup>.

Against staphylococcus aureus in 5 min

and 10 min exposure times, Deconex was the most active one. In 15 min time of exposure, Micro10<sup>+</sup> showed most antibacterial activity.

Hospital staphylococcus aureus affected mostly by Sanosil, then Deconex and Micro10<sup>+</sup> showed the weakest effect at all times of immersion. Regarding standard pseudomonas aeruginosa, in 5 min contact time Deconex was most active one. In 10 min and 15 min contact time Sanosil and Micro10<sup>+</sup> killed more bacteria than Deconex.

On hospital pseudomonas aeruginosa, in all three times of immersion, Sanosil and Deconex had same effects. In addition it was shown that Micro10<sup>+</sup> was weaker compared to the two others. Detailed results of the effects of disinfectants on standard and hospital staphylococcus aureus and on standard and hospital pseudomonas aeruginosa are presented in Table 3 and 4 respectively.

Time	Standard staphylococcus aureus			Hospital staphylococcus aureus		
	5min	10min	15min	5min	10min	15min
Solution	(Mean±SD)	(Mean±SD)	(Mean±SD)	(Mean±SD)	(Mean±SD)	(Mean±SD)
Sanosil	19 ± 11.13	2.66 ± 2.08	2.66 ± 2.88	1.33 ± 1.52	0.33 ± 0.57	0.33 ± 0.57
Deconex	3.33 ± 2.3	0.66 ± 1.15	0.66 ± 0.57	1.66 ± 1.52	1.66 ± 2.08	1 ± 0
Miro10 <sup>+</sup>	6 ± 5.29	5 ± 2.64	0	13 ± 9.64	14.64 ± 10.59	3.33 ± 2.51
Total	9.11 ± 9.84	2.77 ± 2.58	1.11 ± 1.9	5.33 ± 7.58	5.55 ± 8.73	1.55 ± 1.87
	$\chi^2 = 5.109$ P = 0.075	$\chi^2 = 4.545$ P = 0.103	$\chi^2 = 5.627$ P = 0.06	$\chi^2 = 2.94$ P = 0.23	$\chi^2 = 6.006$ P = 0.05	$\chi^2 = 5.279$ P = 0.071

**Table 3.** Comparison colony counts of standard and hospital staphylococcus aureus according disinfectant types and contact times.

Time	Standard pseudomonas aeruginosa			Hospital pseudomonas aeruginosa		
	5min	10min	15min	5min	10min	15min
Solution	(Mean±SD)	(Mean±SD)	(Mean±SD)	(Mean±SD)	(Mean±SD)	(Mean±SD)
Sanosil	30.66±19.85	4.33±5.85	0.33±0.57	0.33±0.57	0	0
Deconex	25±4.35	20.66±6.02	6±2	0.33±0.57	0	0
Miro10 <sup>+</sup>	38.33±7.63	10.66±8.14	2±1.73	19.66±10.01	1.33±2.3	1.33±2.3
Total	31.33±12.3	11.88±9.22	2.77±2.86	6.77±10.89	0.44±1.33	0.44±1.33
	$\chi^2 = 2.98$ P = 0.225	$\chi^2 = 4.728$ P = 0.094	$\chi^2 = 6.386$ P = 0.041	$\chi^2 = 5.945$ P = 0.051	$\chi^2 = 2$ P = 0.368	$\chi^2 = 2$ P = 0.368

**Table 4.** Comparison colony counts of standard and hospital pseudomonas aeruginosa according disinfectant types and contact times.

## Discussion:

In the present study, orthodontic plier disinfection using three different disinfectants was assessed. In most tests, Sanosil was more efficient than Deconex and both were more

efficient than Micro10<sup>+</sup>. The studied disinfectants reduced mean colony counts even after 5 min immersion significantly. Generally antimicrobial activity increased by increasing immersion time.

In Ghahremanloo *et al.* study, alginate discs were immersed for 5 min in disinfectant solutions.<sup>13</sup> Sanosil D2 antimicrobial activity was superior to Deconex 2%. In agreement with the aforementioned study, in our study in 5 min immersion time, Sanosil D2 was more effective than Deconex 2%.

Taheri *et al* showed significant decrease of microorganisms after using Sanosil 2% on dental instruments and the exposure time with disinfectant was not included in this study.<sup>5</sup> However, consistent with our study, it was shown that Sanosil was an effective disinfectant.

Almeida *et al.* concluded that glutaraldehyde 2% is an efficient disinfectant for orthodontic pliers.<sup>8</sup> Although glutaraldehyde is an effective solution and is able to eliminate bacteria from orthodontic pliers' surfaces, the effect is depending on the time with the contact times of 30 min.<sup>8</sup> It was reported that, 30 min for plier disinfection in orthodontic practice is relatively long time period. Indeed, disadvantages of glutaraldehyde such as unpleasant odor, toxic fumes that irritate eye and respiratory system, skin irritation and staining of instruments reduces dentists' tendency to choose it as disinfectant solution.<sup>14, 15</sup> Among disinfectants used in the current study, Micro10<sup>+</sup> and Sanosil are odorless and Deconex has a pleasant smell.<sup>16</sup>

In Saboori *et al.* study both Micro10<sup>+</sup> 2% and Deconex 53plus with 1 hour contact time considered as high level disinfectant and all cell cultures were negative.<sup>16</sup> In the current study, contact time was in the range 5-15 min. Micro10<sup>+</sup> concentration was 5% and Deconex concentration was 2%. In addition to the less exposure times of experiments in the current study, disinfectants have significantly reduced colony counts. Probably by some minutes increasing contact time, microorganisms will be completely eliminated.

As appear in positive control group results, autoclave sterilized pliers perfectly. Saturated steam sterilization is superior to the disinfectant solutions, however; considering time and instrument limitations in the orthodontic practice, it seems that disinfectant solutions are more applicable.

In 15 min immersion, results were not

significantly different and all three types of disinfectants showed approximately same performance. Therefore, in this exposure time, disinfectant selection is depending on other specifications like price, corrosivity and availability.

In exposure time of 5 min and 10 min, regardless of bacteria type, Sanosil demonstrated the superior activity and is the suggested disinfectant. This finding may be attributed to more antimicrobial activity of hydrogen peroxide disinfectants compare to the quaternary ammonium compounds.<sup>17</sup> Weakest disinfectant in 5 min and 10 min exposure times was Micro10<sup>+</sup>. Lack of access to Sanosil or Deconex may be the only reason to choose Micro10<sup>+</sup> for disinfecting pliers in 5 min or 10 min times.

Brady *et al.* have demonstrated higher antimicrobial activity of the silver-based disinfectant compare to QACs.<sup>18</sup> The results shown in the present study are in agreement with the study of Brady *et al.*. Therefore, Sanosil which is containing silver ion, in contact times ≤10 min was significantly more effective than QACs.

According to the previous studies different bacteria reacted differently to disinfectants. If standard staphylococcus aureus is the most common type of microorganism, in 10 min immersion time, Deconex will be more effective than others. In 15 min time of exposure Micro10<sup>+</sup> completely eliminated above microorganism and achieved the first rank. Deconex was more active against standard staphylococcus aureus compare to Sanosil. It was shown that on standard staphylococcus aureus, quaternary ammonium products were more efficient than hydrogen peroxide products.

According Table 3, for disinfecting against hospital staphylococcus aureus Sanosil could be the first choice. In this regard it is better not to use Micro10<sup>+</sup>, particularly in contact times less than 15 min.

Although Deconex showed better effect on the standard pseudomonas aeruginosa in 5 min compared to the two others (Table 4), increasing immersion time quite improved the effect of Sanosil and Micro10<sup>+</sup> as most efficient disinfectants. Study Tables (Table 3,4), revealed the disinfectants need more contact time to kill standard pseudomonas aeruginosa compare to others.



In this study, 10 min contact with Sanosil or Deconex was sufficient for completely elimination of hospital pseudomonas aeruginosa (Table 4). Micro10<sup>+</sup> was so weaker than the two others in 5 min contact time.

Although effectiveness of antimicrobial disinfectants was evaluated by reduction of microbial counts in different studies, no threshold values for colony counts were defined.<sup>19</sup> The clinical acceptable threshold values of antimicrobial activity, also depend on the immunologic condition of the patients.<sup>19</sup> Moreover methodologies are different among studies. Therefore direct comparing different studies to introduce most effective disinfectant should be done cautiously. However, further investigation on this subject is needed.

Selection a specific disinfectant solution is dependent on a number of factors such as: toxicity, corrosivity, staining, price, availability, level and speed of antimicrobial activity.<sup>11</sup> In dental and especially orthodontic offices which have high patient turn over may be the most important of all the requirements is rapid and appropriate antimicrobial activity of disinfectant. Although sterilization is ideal, it seems the cleaning followed by disinfection is more practical.

Effectiveness of chemical agents in disinfection process is somewhat dependent on the morphology and surface characteristics of the instrument. It is well understood that the more roughness of surfaces, the less will be the contact of all surfaces with the disinfectant solution.<sup>11</sup> Adams plier with smooth surfaces was used in the current study while some orthodontic instruments such as mosquito forceps and weingart plier have rough blades. Disinfecting such pliers may need more contact time.

However, as found in literatures, it should be noted that disinfection is not a substitute for sterilization.<sup>8</sup> All instruments that can be sterilized should never suffer disinfection alone.

In this research antibacterial activity of disinfectants was evaluated on Adams pliers. Assess sporicidal activity and testing disinfection of pliers with more surface roughness could be suggested for future investigations.

## Conclusions:

Within the limits of this experiment, in disinfection orthodontic pliers, regardless of bacteria type, Sanosil D2 was the first choice and

acted as most rapid one. Deconex 53plus achieved the second rank. Micro10<sup>+</sup> could be a possible alternative but may be better not to use it in contact times less than 15 minutes. In other words, in most tests the disinfectant containing hydrogen peroxide and silver ion (Sanosil) was more efficient than quaternary ammonium compounds (Micro10<sup>+</sup> and Deconex 53plus). All three types of disinfectants, even in 5 minutes contact time, significantly reduced the number of bacteria. However, disinfection is not perfect and ideal is sterilization.

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