Instrument Sterilization In Orthodontic Offices

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Cold sterilization using various chemical solutions was popularized in the 1940's by extensive World War II battlefield usage. It appeared the perfect answer for the sterilization of the many dental instruments which would be dulled or rusted by steam autoclaving. Sterilization indicates the erroneous use of the word, the substitution of sterilization for disinfection and its accompanying false security in the clinic.

The distinction between these terms is important.

Sterilization is the destruction of all microbal forms including viruses.

Disinfection refers to the destruction of pathogenic microorganisms only and is often applied to procedures which are incapable of destroying spores and certain resistant pathogenic microorganisms such as tubercle bacilli and hepatitis viruses.

Today's concern for the spread of type B hepatitis in dental offices and the carrier state of this disease among dentists has led various authors[1] to suggest the removal of chemical methods of disinfection from clinical dentistry.

Lyons[2] found quaternary ammonium compounds (QAC's) present a number of problems in preparation and use. In summary they are as follows: 1. inactivation by soap, 2. reduced activity in the presence of metal ions common in natural water, 3. reduced effectiveness in the presence of organic matter, 4. incompatibility with a number of chemical substances commonly used in dental offices, 5. lack of activity against mycobacterium tuberculosis, 6. effectiveness against a limited range of viruses, 7. limited effectiveness against gram negative organisms, 8. removal from solution by rubber, cotton, gauze and skin, and 9. not sporicidal.

In 1974 the American Association of Dental Schools resolved that disinfection of dental instruments with chemical agents is unacceptable in preventing the transmission of infectious diseases.[3]

Since 1975 8% solution of formaldehyde in alcohol and 2% aqueous solution of activated glutaraldehyde are listed as the two disinfectant solutions of choice for dental instruments by the Department of the Army.[4] QAC's have been removed from their listing.

Even though extensive research has shown the various QAC's to have serious deficiencies, Perkulis, Engelhard, and Kramer reported complete sterilization of contaminated dental burs in three to five minutes utilizing benzalkonium chloride (Zepherin) in a standard ultrasonic instrument cleaning tank.[5] Malveaux, Whitehurst, and Magerman reported effective destruction of bacterial spores by three different QAC's.[6] Lyons, in discussing these results, notes that by selecting the proper laboratory technique one can show the cationics are either poor or unusually good disinfectants. He observes that, without proper subculture media when testing QAC's, results can be obtained which would lead one to conclude that the quaternary ammonium compounds are even more effective as sporicidal agents than a steam autoclave.

Of the available sterilization systems, steam autoclaving is the standard and most common form used, but is generally unacceptable to orthodontists because of the severe rusting and corrosion of plier joints and other nonstainless instruments.

Ethylene oxide gas, while a safe and effective sterilizing agent, is also seldom used in private practice since it requires from two to six hours exposure time.

Dry heat sterilization is a safe, convenient system and does overcome the rusting and corrosion problem, but it also has the disadvantage of a long exposure time,

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from one to one and a half hours.

Unsaturated chemical vapor sterilization can conveniently provide complete sterilization of instruments in 30 minutes and without deleterious effects on metal surfaces.

In his 1977 test on sterilization, Block notes that both dry heat and vapor sterilization are practical for sterilizing orthodontic pliers since neither rusts nor corrodes dry instruments.[7] He feels that the formaldehyde alcohol vapor pressure system has some advantages in its shorter sterilization cycle.

In spite of the reported deficiencies, the QAC solutions remain the principal form of instrument disinfection in orthodontic offices. A survey of 50 offices in the Santa Clara Valley and surrounding area conducted by the author in December, 1977 documented the following:

1. All use cold disinfectant solutions to some extent.
2. 47 of 50 rely totally on cold disinfectant solution for instrument disinfection.
3. Two use cold disinfectant solutions, but use only alcohol to wipe pliers between patients.
4. One office uses a steam autoclave but for surgical instruments only.

Forty-nine offices used QAC's: germicidal concentrates (Codesco, Bosworth, Super-Dent, Health-Co, Dental Ease, PPC, Getz, Darby, Graham) and Cetylcide, Mann Solution, Zepherin and Benz-All.

Of interest is that only one of 50 offices use Cidex 7, a 2% buffered glutaraldehyde solution, which was accepted in 1973 by the Council on Dental Therapeutics[8] of the American Dental Association. It is considered to provide a high level of disinfection with only 10 minute immersions and sterilization with 10 hour immersions. The principal disadvantage is that it is more caustic than the QAC's and the possibility of skin sensitivity does exist.[9]

Sterilization of orthodontic instruments has not been considered critical by many orthodontists as evidenced by the continued reliance on the QAC's, even though sterilization systems are now available with comparable time cycles and which reportedly do not harm instruments.

This study was undertaken to evaluate the level of disinfection of hand instruments in the contemporary orthodontic office and to determine the feasibility and effects of alternative disinfection or sterilization techniques.

Materials and Methods

Bacterial sampling was done in three orthodontic offices. Office selection was based on the use of quaternary ammonium compounds (QAC) as the only means of disinfection and the doctors' willingness to participate. No attempt was made to alter their usual preparation or technique.

PART A: For ten days in each office, two 1 ml samples of the "in use" cold disinfectant solution were taken at 2:00 p.m. Using sterile pipettes, the samples were placed into two tubes each containing 9 ml of nutrient broth (Difco) and allowed to stand for 15 minutes. The above procedure was repeated taking samples from an unused container of solution prepared at the same time as the "in use" solution as a control.

After 15 minutes, 0.1 ml of E. Coli (gram negative) organisms in suspension was added to one tube of the "in use" solution and to one tube of the control solution; 0.1 ml of Staph Aureus (gram positive) was added to the other tube of "in use" solution and the other tube of control solution. All four tubes were mixed gently and racked.

PART B: For ten days in each office, daily cultures with sterile, disposable cotton swabs were made at 8:00 a.m. and 2:00 p.m. A typical serrated tip plier and dental scaler ready for use were randomly sampled at the chair.

Using sterile technique, the cotton swab was moistened in the sterile nutrient broth tube and rubbed over the working end of the plier or scaler. The swab was then

placed halfway into the nutrient broth tube again and the stick broken, leaving only the distal end in the tube. A sterile swab was likewise placed in a sterile nutrient broth tube as a control. All tubes were labeled and racked.

PART C: In the author's office the following additional alterations were made and random pliers and scalers sampled in the same manner as described above:

1. At one chair all hand instruments were wiped with 70% isopropyl alcohol on sterile 2"x2" gauze squares as the only means of disinfection.
2. At one chair all hand instruments were scrubbed in a liquid detergent and tap water solution, rinsed under tap water, and placed in a QAC solution, "Cetylcide," for 25 minutes.
3. At one chair all hand instruments were scrubbed in a liquid detergent and tap water solution, rinsed under tap water, and placed in a glutaraldehyde solution, "Cidex 7," for 10 minutes.
4. At one chair all hand instruments were scrubbed in a liquid detergent and tap water solution, rinsed under tap water, blotted dry, and heat sterilized for 30 minutes using a chemical vapor sterilizer, "Harvey Chemiclave 5000."

All samples were transported daily to an independent medical laboratory.

Laboratory Procedures

The samples were incubated at 37°C for 48 hours and observed for growth. Using standard techniques, all tubes were plated on blood agar and on Bacto-D/E Neutralizing Agar (Difco), again incubated at 37°C for 48 hours, observed again for growth, and organisms identified.

Results

1. PART A: No E. Coli or Staph Aureus growth was recorded in the QAC chemical disinfectant samples or controls in any of the three offices over a period of ten working days. However, a Bacillus Species organism was cultured from the gram positive sample of "in use" solution in Office #1 on Day #3; a gram negative rod was cultured from the gram positive sample of "in use" solution in Office #3 on Day #4.
2. PART B: Contaminant bacterial growth was cultured from the sampled chairside instruments at least once in each of the three offices: Office #1, four times; Office #2, once, and Office #3, six times.
3. PART C: In Office #1 bacterial growth was cultured from the sampled chairside instruments regardless of the means of disinfection or sterilization employed as follows: alcohol sponge wipe, 13 of 40 samples; 2% buffered glutaraldehyde solution, 6 of 40 samples; typical QAC solution and detergent wash, 3 of 40 samples; chemical-vapor sterilizer, 3 of 40 samples.

Discussion

The principal value of this study has been the increased educational feedback to the staff personnel involved. A greater awareness of their responsibility in creating an environment that is clean and harmless to the patients and to themselves has evolved. All participants have experienced an increased interest in proper sterilization procedures.

The results of PART A showed continual bacteriocidal activity of the QAC solutions over the ten day period. In each office the solutions were changed once per week with equal results. Only Office #1 used distilled water in its preparation. Again, no superiority was demonstrated in its action against the known bacterial samples.

In PART B, the comparison of pliers and scalers at the chair in three offices demonstrated vegetative contamination on the working ends in all offices: 2.5% of

the time in Office #2; 10% of the time in Office #1; and 15% of the time in Office #3. No meaningful distinction is made between the three offices. The serrated pliers accounted for 73% of the positive samples. This could indicate a need for more thorough debridement of serrated tips prior to immersion.

In summary, if Office #2's better record is due to procedures, it could be because they adhere most closely to both prewashing of bloody instruments and sufficient time in solution. Office #1 does adhere to the recommended time, but instruments are not prewashed. Office #3 routinely rinses all instruments before immersion, but often uses a very short immersion time.

Responses from the 50 office survey also showed considerable variation in length of time the instruments were left in the solution, from 30 seconds to 30 minutes. How often solutions are changed also varied considerably, from daily to weekly. Finally, only four of 50 offices used distilled water instead of tap water even though water with a high mineral content has been shown to inactivate QAC solutions.[2]

Hand instruments routinely disinfected in the QAC solutions remain bright and shiny, show no signs of corrosion, and joints work freely. This "like new" appearance together with the noncaustic nature of the solutions, the pleasant odor, the ease of use, and the short time cycle all contribute to the QAC's continued usage in a rather casual, nonregulated regimen. It is really too easy to interrupt the disinfecting cycle for that favorite instrument or to add additional instruments midcycle. Sampling as done in PART A could further this easy routine. It must be remembered that these tests are merely a demonstration of the QAC's germicidal effectiveness against two known vegetative bacteria and should not be construed as supporting evidence for their continued usage.

All QAC's, by federal regulation, must state right on the bottle under the directions, "Germicide containing a Quaternary Ammonium derivitive should not be relied on to destroy spore-bearing organisms, Mycobacterium tuberculosis, or the etiologic agent of viral hepatitis."

In PART C the comparison of the effect of four alternative disinfecting and sterilizing procedures with the regular office procedure in Office #1 shows no dramatic difference when instruments were cultured at the chair except for the alcohol sponge wipe. Vegetative bacteria was cultured on either the plier, the scaler, or both on nine of the ten days, 32% of the time when 70% isopropyl alcohol was used on sterile sponges. This level of vegetative contamination precludes the author's continued usage of this method of disinfection. It seems that while 70% to 90% isopropyl or ethyl alcohol is known to be germicidal against vegetative bacterial growth, it does not provide continued protection in open storage. Substituting a chemical-vapor sterilizer, 2% glutaraldehyde solutions, or adding a detergent prewashing step did not demonstrate any great improvement in sterility of the instruments at the chair over the QAC solutions. This could be explained by the possibility of a remaining film of QAC solution on the instruments in storage. No ongoing protection remains after an alcohol wipe, chemical-vapor sterilization, nor when 2% glutaraldehyde solution is used which must be rinsed off to avoid skin irritation.

Other sources of contamination appear to be in the way instruments are handled and stored. To provide total sterility, it would be necessary for an orthodontic office to become a surgical operating room complete with draped patients, gloved staff, masks, sterile gowns, towels, instrument packs, and filtered air.

Practicality being somewhat short of this, patients should still have the security of knowing that they came into an office for orthodontic care and likely that's all they got. To foster this, the primary need is to prevent cross contamination. Instru-

ments contaminated with blood or saliva from one patient must not be reused without thorough cleansing and sterilization before use on another patient. Of the various methods compared in this study, the chemical-vapor sterilizer is the only system accepted by the Environmental Protection Agency of the U. S. Government as a sterilant in a 30 minute time period. In regular usage for six weeks the chemical-vapor sterilizer was found to be easily incorporated into the clinic routine. Corrosion of instruments was not found to be a problem. The plier joints continue to work freely. Crawford, at the University of North Carolina, describes the use of 10% lubricating oil in a 90% alcohol solution as a prewipe on orthodontic pliers before sterilization in a chemical-vapor sterilizer.[10] One specific problem encountered was the necessity of a cooling-down period for the instruments. They are not immediately ready for use. On a permanent installation basis the sterilizer could easily be built into existing cabinets. Considerable counter space and additional sink space are necessary to wash and dry the instruments prior to the sterilizing cycle. While not used during the testing period, the incorporation of an ultrasonic cleaning tank should be an excellent alternative to hand scrubbing which is both dangerous to the staff personnel and time consuming. A major problem seen in the conversion of a typical orthodontic office from cold disinfectant to complete sterilization would be the obvious need for some multiple of sterilizers and duplicate instruments. A high number of short adjustment appointments, using multiple chairs on a given afternoon, creates a sterilization problem specific to orthodontic practice. In a busy office a bank of sterilizers, perhaps even one for each cold disinfectant tank, is conceivable. The author can see the need for at least four sets of duplicate instruments at each chair to continue operating with the convenience of everything being identical and everything being stored at the chair. An alternative would be the development of a sterilization area with centralized storage and complete tray setups. This should require fewer instruments and could additionally better maintain the sterility of the instruments in storage.

In 1971, using the rigid AOAC test methods (Association of Agricultural Chemists, which tests disinfectants for the FDA), 2% glutaraldehyde solution was considered a superior chemical disinfectant by the U.S. Army Institute of Dental Research[11] when compared with a benzalkonium chloride solution. This glutaraldehyde solution, likewise, was no problem to incorporate into the clinic routine. During the study the instruments were rinsed with sterile water after immersion as recommended on the label. In continued practice the alternate procedure, also recommended by the manufacturer, of rinsing with hot tap water has been employed. No skin irritation to staff or patients has been observed in the past eight weeks.

Some slight staining of orthodontic pliers was observed, but was not found to be offensive. The plier joints continue to work smoothly.

On the basis of its virucidal properties alone, the 2% buffered glutaraldehyde solution would seem the chemical solution of choice for orthodontic instruments not being sterilized in a chemical-vapor sterilizer.[12] While the virucidal effects of glutaraldehyde have not been proven against the specific virus of Hepatitis B, one might speculate, as have Crawford[10] and others[13], that it should be since it has proven so effective against all spore formers and viruses tested to date.

It was demonstrated in this study that chairside orthodontic instruments were often contaminated regardless of the form of disinfectant or sterilization used. During the study staff personnel were observed holding instruments by their working ends when storing and when arranging them on the tray in preparation for the next patient. It seems that routine disinfection and

sterilizing techniques which the practitioner may take for granted are just not grasped by all chairside personnel, especially those with no formal training. Even the necessity for such things as daily cleaning of finger nails, thorough washing of hands between patients, and careful disinfection of the chair and unit are not as obvious to nonformally trained personnel as we may think. To correct this the author would propose:

1. A university-sponsored basic course in office sterilization specifically for orthodontic assistants.
2. An association-sponsored continuing education tape cassette training course on office sterilization. Within such courses a requirement for in-office sampling could provide a meaningful teaching procedure which dramatically supplements didactic material and promotes staff involvement.
3. Thorough testing of sterilization techniques in the State administered registered dental assistant examination.

This seems reasonable to the author who feels that office sterilization techniques are as important to patient and staff safety as radiation safety which is already regulated by the state of California.

If, indeed, the best possible care of the patient is our intent, we must be willing to review our established routines, make corrections in faulty techniques, and update our systems as better products become available. We do this continuously in our orthodontic treatment procedures. In the author's opinion it is past time to do this in our instrument *sterilization* procedures as well.

Conclusion

1. Three different quaternary ammonium compound solutions remained bactericidal against specific vegetative bacteria in three orthodontic offices over a ten day working period. However, no spore formers or viruses were tested.
2. Bacterial contaminants were cultured on pliers and scalers at the chair at least once in each of three orthodontic offices sampled twice a day for ten working days.
3. Sampled chairside instruments wiped with an alcohol sponge only, between patients, were contaminated an excessive 32.5% of the time, too frequently to be seriously considered for routine disinfection of pliers.
4. Chairside instruments, sampled regardless of other means of disinfection or sterilization used, were contaminated from 3.5 to 15% of the time. Therefore, storage and handling of orthodontic instruments must be evaluated and upgraded to prevent recontamination of previously sterilized instruments.
5. Staff personnel need courses in sterilization and disinfection procedures to prevent cross contamination from patient to patient and to protect themselves. These courses should be related specifically to orthodontic practice procedures.

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