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Monitoring and analysis of the cleaning effect of spinal surgical instruments by visual track viewer

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ABSTRACT: Objective The present study aims to detect the inner wall cleanliness of spinal luminal instruments with visual track viewer, and to analyze the difficulties of spinal surgical instruments cleaning, so as to improve and perfect the cleaning quality. **Methods** 226 luminal spinal instruments were selected. The luminal cleaning quality of instruments after mechanical cleaning and manual cleaning plus mechanical cleaning were examined by visual track viewer, and the results were statistically analyzed. **Results** In the control group, 113 instruments were cleaned by mechanical cleaning. The clearance rate was 90.26% for bloodstain, 78.76% for stain, 72.57% for foreign body, and 85.84% for tissue residue. In the experimental group after manual cleaning and mechanical cleaning, the clearance rate of bloodstain was 100%, stain was 96.46%, foreign body was 92.03%, tissue residue was 100%. The pollutant clearance rate of experimental group was significantly higher than that of control group ($P<0.05$). **Conclusion** The structure of spinal surgical instruments is complex, and they are difficult to clean. The use of visual track viewer can clearly detect the inner wall of the lumen, find out the cleaning difficulties, check the cleaning quality, and effectively ensure the safety of surgical instruments.

KEY WORDS: Luminal instruments; Visual track viewer; Cleaning quality testing

Introduction

An increasing number of complex medical instruments have been applied in various surgeries as the progress of minimally invasive surgeries. Some surgical instruments are made of special materials, complex in structure, expensive, and difficult to clean^[1]. Cleaning is a prerequisite for qualified sterilization. Failure of cleaning leads to failure of disinfection or sterilization process. The damaged or uneven structure of the lumen provides an environment for microorganisms to multiply. Therefore, timely cleaning is effective in preventing the formation of biofilm, thus ensuring the quality of sterilization^[2]. Visual inspection is a major method of determining cleaning effectiveness^[3]. However, because of lack of detection equipment for the inner wall of the lumen, it is impossible to visually detect scratches, debris, and blood stains on the inner wall,

ultimately resulting in the formation of biofilms that are difficult to remove, which thus become a blind spot in the prevention and control of infections^[4-5].

The visual track viewer is a visualization system for inspecting the passage of endoscopic and canalicular instruments. The narrow channels of luminal instruments are accessed through slim wires to perform visual inspection and to detect the presence of foreign body residues and contamination inside the luminal instruments^[6]. The present study applied a visual track viewer to investigate the cleaning quality of the luminal structures of spinal surgical instruments and to find out the difficulties in cleaning of such surgical instruments, so as to improve the quality of cleaning and to optimize the process.

1 Objects and methods

1.1 Test objects

A total of 226 instruments with lumen were se-

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lected from the spinal surgical instruments received from March through December 2023, of which 121 were intervertebral endoscopes, including spinal spreader, needle, catheter, sleeve, flexible grasper, nucleus pulposus forceps, and outer sheath; and 105 were routine spinal surgical instruments, including sleeve of cardan screw implanter, bone grafter, percutaneous sleeve, cervical lift, fusion device, gun reset pliers, etc.

1.1.1 Inclusion criteria

Spinal surgical instruments after use.

1.1.2 Exclusion criteria

(1) Rust was observed on the surface of the instrument by visual inspection.

(2) Rust was detected on the inner wall of the lumen by the visual track viewer.

1.2 Materials and equipment

Visual track viewer, automatic washing machine, medical cleaning agent, high-pressure water gun, high-pressure air gun, medical cleaning brush, ATP fluorescence detector, and light-source magnifier were used in this study.

1.3 Test methods

A total of 226 instruments were randomly sampled and divided into one control group and one experimental group. The instruments in the control group were cleaned using an automatic washing machine, and the instruments in the experimental group were processed through manual cleaning plus mechanical cleaning. After cleaning, the instruments were visually inspected using a light-source magnifier respectively^[7]. Ten instruments were randomly sampled from each group for ATP fluorescence detection. The lumen was examined using a

visual track viewer by inserting a wire into the lumen, presenting the acquired images on a computer through software and recording the results of the inner wall of each instrument.

1.4 Result determination

The cleaning is determined to be qualified if the inner wall of the lumen is free of blood stains, stains, foreign bodies, and tissue residues.

1.5 Statistical analysis

Excel software was used, and SPSS 22.0 was applied for statistical analysis. $P \leq 0.05$ was considered a statistically significant difference.

2 Results

2.1 Instrument structure

Of the 226 lumen instruments, 148 were open at both ends, 78 had a closed blind end, 92 had a concave and convex structure, and 134 had smooth surfaces with no concave or convexity.

2.2 Pollutant removal

Cleaning quality testing of instruments at the time of reception and after cleaning was performed by means of a light-source magnifier, a visual track viewer, and an ATP fluorescence detector. The pollutants of the 226 instruments include bloodstain (60.62%), stain (78.76%), foreign body (40.71%), and tissue residue (29.65%). The pollutant clearance rates in the control group were 90.26% for bloodstain, 78.76% for stain, 72.57% for foreign body, and 85.84% for tissue residue. The pollutant clearance rates in the experimental group were 100% for bloodstain, 96.46% for stain, 92.03% for foreign body, and 100% for tissue residue (Table 1).

Table 1 Pollutant clearance rates

Date of inspection	Qty	Bloodstain		Stain		Foreign body		Tissue residue	
		Number of contaminated items	Pollutant clearance rate (%)	Number of contaminated items	Pollutant clearance rate (%)	Number of contaminated items	Pollutant clearance rate (%)	Number of contaminated items	Pollutant clearance rate (%)
Control group	113	102	90.26	89	78.76	82	72.57	97	85.84
Experimental group	113	113	100	109	96.46	104	92.03	113	100

cal instruments, most of the lumen instruments suffer from issues such as lack of timely processing or moisturizing after surgery, which may lead to unqualified cleaning. The visual track viewer strengthens the inspection of the inner wall of the lumen after cleaning spinal surgical instruments, in order to find out the defects of inner wall cleaning directly and ensure the cleaning quality^[10].

3.2 Important to manually clean precise luminal instruments

Attention must be paid to the inner wall structure of the lumen instruments. The visual track viewer was used to find out the difficulty and focus of cleaning, and the cleaning program was selected according to the different structures. It was found that the pollutant clearance rate of the experimental group was significantly higher than that of the control group after using manual cleaning plus mechanical cleaning, so we should choose the appropriate type of medical cleaning brush for manual cleaning before using automatic washing. Therefore, we should choose the appropriate type of medical cleaning brush for manual cleaning and then use an automatic washing machine to ensure the cleaning quality^[11].

3.3 Optimization of cleaning process by visualized inspection method

The outer surface of the spinal surgical instrument is easy to clean, whereas contaminants tend to remain due to the special structure of one or both open ends. The concave-convex design in the inner wall increases the difficulty of cleaning, which is consistent with the study of Zhou et al^[12]. The visual track viewer observes the inner wall of spinal surgical instruments and evaluates the cleaning effect, providing a means of inspection to ensure the cleaning quality, optimizing the cleaning process, and verifying the importance of manual cleaning plus mechanical cleaning for precise and complex instruments, thus improving the cleaning quality.

3.4 Comparative analysis of cleaning quality tests

Currently, the routine inspection of each piece of instrument after cleaning is conducted visually or with the light-source magnifier. It is simple, easy

to carry out, and economical. However, the inspection may be interfered with by subjective factors of the inspector and has certain limitations. For example, the instruments are qualified for visual observation, while hidden organic or microbial contaminations still existed. In addition, visual inspection of luminal instruments makes it difficult to evaluate the effectiveness of their internal cleaning^[13]. The ATP fluorescence detection method gives a quantitative cleaning effect by RLU value and comprehensively evaluates the cleaning effect by comparing the values. Nevertheless, the ATP test produces consumables and human operation differences, with no uniform standardized value at present, which requires the manufacturer to provide a qualified value through clinical validation, as a reference basis for determining the cleaning effect^[14]. The visual track viewer, as a luminal inspection system, does not produce consumables and allows observation of the inner wall structure of spinal surgical instruments and discovery of residues, thus visually inspecting the cleaning effect of the inner wall and improving the cleaning quality. However, this method still belongs to the visual inspection, so it is necessary to combine it with the ATP fluorescence test or protein residue test for quantitative detection so that the cleaning quality of surgical instruments can be better evaluated^[15].

4 Conclusion

The present study reveals that spinal luminal instruments have a complex internal structure with one or both open ends. The pollutant clearance rate of manual cleaning plus mechanical cleaning in the experimental group was significantly higher than that of the control group. Therefore, manual cleaning is essential for the inner wall cleaning of the lumen. Furthermore, the visual track viewer allows visual observation of the internal cleanliness of the luminal instruments by entering the inner wall of the luminal instruments through a lens with a light source and performing imaging recording, which is conducive to discovering the cleaning issue of the spinal luminal instruments, improving the cleaning process, and

perfecting the cleaning quality.

References

- [1] M. J. Alfa, "Medical instrument reprocessing: current issues with cleaning and cleaning monitoring," *American Journal of Infection Control*, vol. 47, pp. A10-A16, 2019.
- [2] Y. Yuan and Z.H. Liu, "Study on the heating delay of steam sterilization of loaner instruments with different pulsations," *Chinese Journal of Disinfection*, vol. 37, pp. 428-430, 2020.
- [3] T. C. Liu, Peng C. L., H. P. Wang et al., "SpyGlass application for duodenoscope working channel inspection: Impact on the microbiological surveillance," *World Journal of Gastroenterology*, vol. 26, no. 26, pp. 3767-3779, Jul. 2020.
- [4] S. de Souza Evangelista, N. R. Guimaraes, N. B. Garcia et al., "Effectiveness of manual versus automated cleaning on Staphylococcus epidermidis biofilm removal from the surface of surgical instruments," *American Journal of Infection Control*, vol. 48, no. 3, pp. 267-274, Mar. 2020.
- [5] W. Zhou, C. Ye, X. Huang et al., "Efficacy of cleaning methods for ophthalmic microscopic instruments: a comparison study," *AORN Journal*, vol. 112, no. 2, pp. 112-121, Aug. 2020.
- [6] Y. Huang, Y. Huang, Y. Chen et al., "Factors affecting implementation and pass rates of surgical instrument moistening," *BMC Infectious Diseases*, vol. 21, no. 1, p. 752, 2021.
- [7] World Health Organisation. Decontamination and reprocessing of medical devices for health-care facilities [EB/OL]. [2022-03-10].
- [8] W. Zhang, P.Q. Yan, Y.L. Wang et al., "Evaluation of the cleaning effects of different cleaning methods on luminal instruments by using borescope inspection method," *China Medical Equipment*, vol. 18, pp. 47-51, 2021.
- [9] C. H. Kowalski, K. A. Morelli, D. Schultz et al., "Fungal biofilm architecture produces hypoxic microenvironments that drive antifungal resistance," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 117, no. 36, pp. 22473-22483, Sep 2020.
- [10] J.W. Wu, Y. Cao, C.Y. Yang et al., "Comparison of different detection methods on clean effects of lumen instrument," *China Medical Equipment*, vol. 16, pp. 157-160, 2019.
- [11] C. L. Ofstead and K. M. Hopkins, "Sterilization central: the value of borescopes in detecting damage, soil, fluid, and foreign objects in flexible endoscopes," *Biomedical Instrumentation & Technology*, vol. 54, no. 2, pp. 146-152, Mar. 2020.
- [12] H. Zhou, Q.F. Shi, X.D. Gao et al., "Evaluation of cleaning effect of loaner luminal surgical instruments by endoscopic lumen visual inspection system," *Chinese Journal of Infection Control*, vol. 21, pp. 656-660, 2022.
- [13] C.R. Lin, Y.Q. Jiang and Y.L. Yang, "Effect comparison between two cleaning methods of endoscopic equipment," *Journal of Nursing Science*, vol. 32, pp. 48-49, 64, 2017.
- [14] A.Q. Li, H.T. Li, N. Li et al., "Application of the visual trail viewer combined with ATP biofluorescence assay in the quality control of laparoscopic instrument cleaning," *Chinese Journal of Nosocomiology*, vol. 33, pp. 1277-1280, 2023.
- [15] Y.W. Qiu and J.J. Shi, "Research progress on monitoring methods of cleaning effect of reusable instruments," *Chinese Journal of Disinfection*, vol. 35, pp. 781-783, 2018.

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