

12-25-2023

## Comparison and Assessment of Design, Handling Characteristics, and Efficacy of Hand Instruments in Calculus Removal

Mohan Kumar Pasupuleti

*Department of Periodontics and Implantology, Vishnu Dental College, Bhimavaram, India,*  
mosups@gmail.com

Krishna Ganesh

*Department of Periodontics and Implantology, Vishnu Dental College, Bhimavaram, India,*  
krishnaganeshdr1@gmail.com

Gautami S Penmetsa

*Department of Periodontics and Implantology, Vishnu Dental College, Bhimavaram, India,*  
gautamipenmetsa@gmail.com

Boddeda Anusha

*Department of Periodontics and Implantology, Vishnu Dental College, Bhimavaram, India,*  
anushab@vdc.edu.in

Haripriya Narukurthi

*Department of Periodontics and Implantology, Vishnu Dental College, Bhimavaram, India,*  
harichowdhary1996@gmail.com



Part of the [Dental Hygiene Commons](#), [Dental Materials Commons](#), [Endodontics and Endodontology Commons](#), [Health Economics Commons](#), [Oral and Maxillofacial Surgery Commons](#), [Oral Biology and Oral Pathology Commons](#), [Orthodontics and Orthodontology Commons](#), [Pediatric Dentistry and Pedodontics Commons](#), and the [Periodontics and Periodontology Commons](#)

---

### Recommended Citation

Pasupuleti, M., Ganesh, K., Penmetsa, G., Anusha, B., Narukurthi, H., & Mouna Sahith, K. Comparison and Assessment of Design, Handling Characteristics, and Efficacy of Hand Instruments in Calculus Removal. *J Dent Indones.* 2023;30(3): 171-179

This Article is brought to you for free and open access by the Faculty of Dentistry at UI Scholars Hub. It has been accepted for inclusion in Journal of Dentistry Indonesia by an authorized editor of UI Scholars Hub.

---

# Comparison and Assessment of Design, Handling Characteristics, and Efficacy of Hand Instruments in Calculus Removal

## Authors

Mohan Kumar Pasupuleti, Krishna Ganesh, Gautami S Penmetsa, Boddeda Anusha, Haripriya Narukurthi, and Kommina Mouna Sahith

## ORIGINAL ARTICLE

# Comparison and Assessment of Design, Handling Characteristics, and Efficacy of Hand Instruments in Calculus Removal

Mohan Kumar Pasupuleti\*, Krishna Ganesh, Gautami S Penmetsa, Boddada Anusha, Haripriya Narukurthi, Kommina Mouna Sahith

*Department of Periodontics and Implantology, Vishnu Dental College, Bhimavaram, India*

*\*Correspondence e-mail to: mosups@gmail.com*

## ABSTRACT

**Objective:** primary objective of periodontal therapy is to remove supra and subgingival deposits from the tooth surface to stop disease progression. The purpose of the study is to address the instrument selection and its efficacy in calculus removal. **Methods:** A total of 50 subjects who fulfilled the criteria were included in the study. Participants were subjected to a complete periodontal examination, and the responses from 50 dental house surgeons were compared based on the instrument design, handling characteristics, and efficacy of calculus removal by using two sets of instruments. **Results:** The LM instrument was rated as best (40 out of 50 participants) based on usability features like weight, the diameter of the handle, material, and surface characteristics. Handgrip, static friction, and surface characteristics features (43&7; 45&5; 40&10) were more for LM instruments when compared to Hu-friedy instruments. When compared to efficacy in calculus removal it was easy with Hu-Friedy instruments. **Conclusion:** Handling characteristics and efficacy of instruments depend on the design and type of material used to manufacture instruments. Cooperation between researchers, manufacturers, and experienced dental professionals is needed for an active and open-minded process during the development of dental instruments.

**Key words:** calculus, design characteristics, hand instruments, scaling

How to cite this article: Pasupuleti MK, Ganesh K, Penmetsa GS, Anusha B, Narukurthi H, Sahith KM. Comparison and assessment of design, handling characteristics, and efficacy of hand instruments in calculus removal. *J Dent Indones.* 2023;30(3): 177-191

## INTRODUCTION

The major etiological factor for periodontal disease development is dental plaque. Elimination of supra- and sub-gingival plaque and calculus is the basic aspect of the treatment of periodontal disease. Dental calculus is a mineralized plaque, and it has the property of absorbing various toxic products that can damage the periodontal tissues, it has to be accurately detected and thoroughly removed for adequate periodontal therapy. Many techniques have been used to identify and remove calculus deposits present on the root surface.<sup>1</sup>

Mechanical plaque and calculus removal have been commonly accepted to be the basis for periodontal treatment. Periodontal instrumentation involves both scaling and root debridement. Scaling is the process where plaque and calculus are removed from the

enamel surfaces. Hand instruments used for non-surgical periodontal therapy are scalers, chisels, hoes, files, and curettes. Thorough instrumentation will help to create an environment free of plaque, calculus, and microorganisms which further prevents the destructive process of periodontal disease and promotes the health of the patient.<sup>2</sup>

Dentists can achieve successful treatment outcomes in nonsurgical periodontal therapy through the combined use of hand and power instrumentation. Newly engineered designs in both modalities make them more valuable and effective than ever. Today's dentists have the advantage of providing optimal periodontal patient care to increase clinical success, improve outcomes, and, ultimately, help patients achieve good oral and overall health.<sup>1</sup>

Instrument handles come in a variety of diameters, shapes, padding, weights, and materials. Using hand instruments with different diameter handles can reduce hand stress and repetitive motion injuries. A primary consideration in handle choice is clinician comfort, which is critical to lessen the effect of repetitive strain injuries. A wide variety of handles are available. Handles with larger diameters may prevent finger cramping and reduce hand fatigue. Research suggests that the optimal handle diameter should be at least 10 mm and the optimal weight should be 15 g or less.<sup>2</sup>

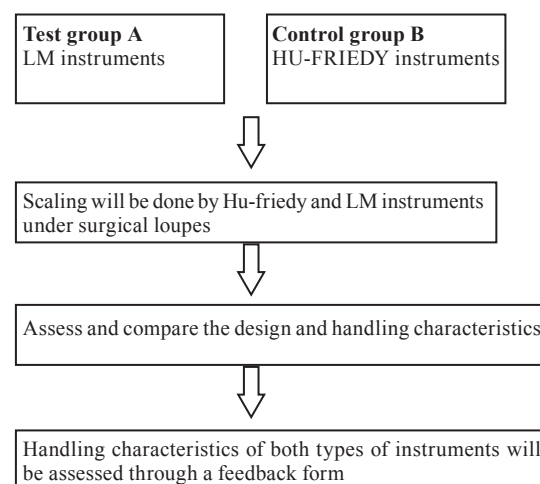
The main focus of the researchers is on how to improve the operator's comfort and work efficiency through instrumentation. To achieve better comfort and efficacy different hand instruments were tried by the dental manufacturers by modifying the design characteristics to increase the work efficiency.<sup>3</sup> Clinician comfort is the primary consideration. Instruments manufactured with a textured grip surface or surfaces made with materials that increase friction between gloved fingers and the instrument decrease pinch forces. Since 1908, Hu-Friedy has been putting the highest quality, most innovative dental products in the hands of dental professionals worldwide.<sup>3</sup>

The dental instruments used by the professionals need to be performed consistently with every patient, every day to show the critical skills of the dental profession. At Hu-Friedy, every instrument, from its proprietary metal to the unique and textured handle design, is created to perform at its best while performing dental procedures. Hu-Friedy instruments have a superior stainless steel alloy that stays sharper for a longer time and needs fewer requirements for sharpening. Clinical efficiency and greater productivity are the top characteristic uses of Hu-Friedy for dental practice.<sup>4</sup> The LM Sharp Diamond instruments are completely sharpened free. These instruments are made from an exceptionally durable special metal alloy, and their wear resistance is enhanced by a protective micro membrane coating. Sharp Diamond instruments with LM-ErgoSense handles are especially suitable for clinicians who use hand instruments frequently and want to minimize the time spent maintaining dental instruments.<sup>5</sup>

These instruments combine optimal characteristics of superior sharpness, tactile sensitivity, and comfort. To date, there is no literature comparing ergonomics and clinical outcomes. Hence, we have undertaken this research work to assess the design, handling characteristics, and efficacy of calculus removal by Hu-Friedy and LM ErgoSense hand instruments.

## METHODS

This was a split-mouth randomized clinical trial conducted to compare and assess the instrument



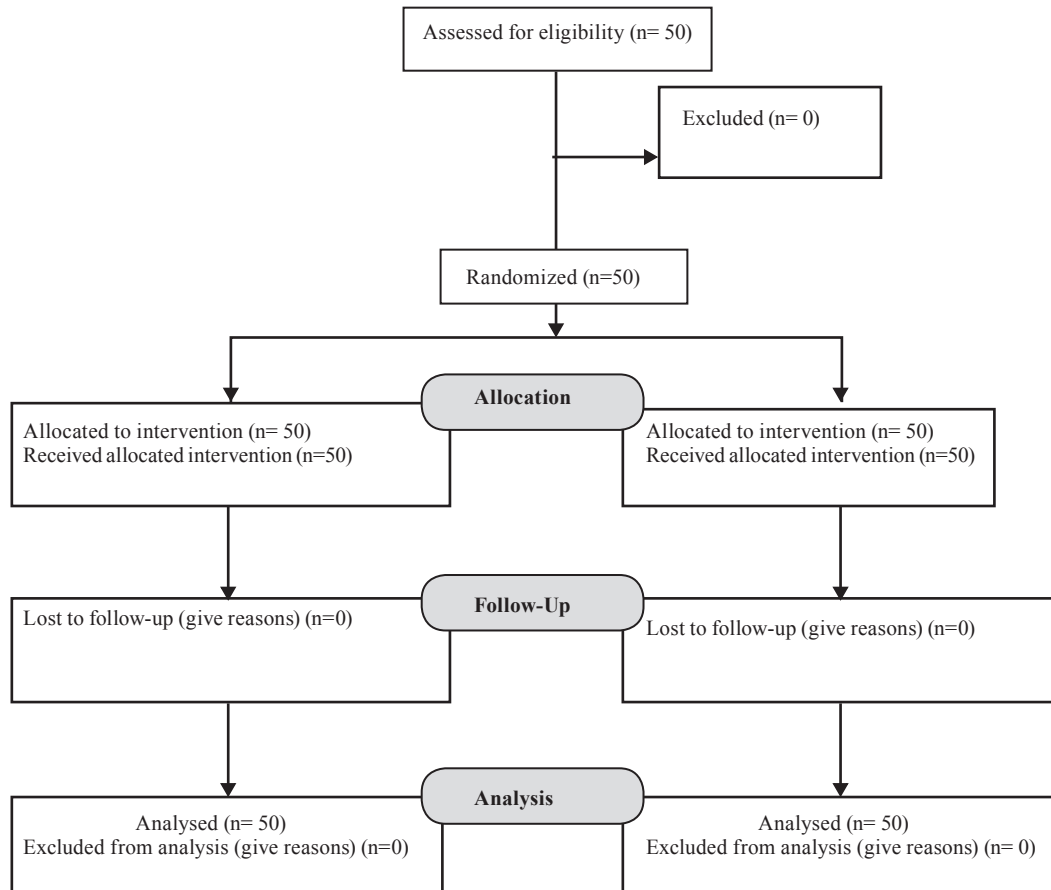
Lm: LM hand instruments; Hf: Hu-Friedy hand instruments

**Figure 1.** Flow chart of the study design.

design, handling characteristics, and efficacy of two different sets of hand instruments on calculus removal during the scaling procedure. All the patients were selected from those attending the Department of Periodontics and Implantology, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India, from September 2021 and completed the entire study by February 2022 (Figure 1). The study was approved, and ethical clearance was obtained from the Institutional Ethics Committee with RefNo: IECVDC/2021/UG01/PI/IVV/51 and also approved under Clinical Trials Registry- India (CTRI/2021/09/036903). The study followed the Consolidated Standards of Reporting Trials (CONSORT) guidelines (Figure 2).

Before starting the study, standardization and calibration exercise was performed on the clinicians to achieve consistency. Ten clinicians, each in 5 batches, were trained in professional supra gingival scaling and demonstration given on the usage of both types of hand instruments given by the Periodontist. Operators were asked for the best instrument while checking for hand instrument design, handling characteristics, and efficiency in calculus removal. The responses from the clinicians were assessed, and Cronbach's alpha value was calculated as a measure of consistency which is 0.9. There was 90% agreement between the clinicians in performing the procedure by both sets of instruments.

Those subjects who satisfied the below-mentioned inclusion and exclusion criteria were enrolled in the study. Inclusion criteria are Patients diagnosed with mild to moderate periodontitis according to AAP guidelines, 1999, Minimum of 20 teeth in the mouth, the age range of 25-65 years, Patients who have not received periodontal treatment for the past 6 months to 1 year. Exclusion criteria are Patients with uncontrolled systemic diseases and physically and mentally challenged individuals.



**Figure 2.** CONSORT Flow Diagram

Sample size calculation: G-power software version 3.10 was used to calculate the sample size.

A sample size of 50 was obtained in the study.

Input: Tail(s) = Two  
Effect size = 0.7857143  
 $\alpha$  err prob = 0.05  
Power (1- $\beta$  err prob) = 0.80

Output: Noncentrality parameter  $\delta$  = 3.1746499  
Critical t = 2.2009852  
Df = 15  
Total sample size = 50  
Actual power = 0.8234309

The envelope randomization method was followed, and participating clinicians were given randomly generated treatment allocations within sealed envelopes. Sequence generation was done by the primary investigator, and implementation or assignment of study groups was done by the second investigator. Immediately after the arrival of the patient, an envelope was opened and offered the treatment after the complete medical and dental examination.

A total of 50 subjects with chronic periodontitis who fulfilled the criteria were included in the study. The entire purpose of the study was explained to

the patients, and informed consent was obtained. Participants were subjected to a complete periodontal examination. A total of 100 sites in 50 patients were included in the study after recording the calculus index-simplified (CI-s). Only the patients with +2/+3 scores of supra gingival calculus on either side of quadrants were included.

The mandibular anterior (lingual surface) and maxillary posteriors (buccal surface) were selected for the study. The selected sites were divided into lower left front and lower right front teeth or upper left back and upper right back teeth (split-mouth design study). Once the sites were selected, they were randomly subjected to instrumentation using 2 different sets of hand scalers. The same 2 sets of hand instruments were used to do scaling by all the 50 operators to test the efficacy in calculus removal and to check the sharpness of the instrument at the end of completion of the study.

Group A: Scaling done with LM instruments under surgical loupes in one-half of the mouth. LM hand instruments used were Mc Call LM 11 A-12A Scaler and Sickel LM 23 Scaler,

Group B: Scaling done with HU-FRIEDY instruments under surgical loupes in another half of the mouth. The

instruments used were Hu-Friedy Universal Scaler SU 15/30, and Posterior Scaler SJ 31/326.

Once the scaling was done on one quadrant by LM instruments, the patient was given an appointment for scaling on the other quadrant by Hu-Friedy instruments to avoid errors in describing the discomfort or fatigue immediately after treatment. The calibration was performed similarly manner during clinical training and the instrument sequence and arch sequence randomization followed in all the patients.

The instruments were evaluated with the use of a subjective analysis of usability and by objective measurements of the handgrip, static friction, and surface characteristics of both types of hand instruments used for scaling. Instrument efficiency was quantified by measuring the time required to completely remove calculus.

In the objective measurements, instrument design characteristics like weight measured by a digital weighing machine (Eagle digital pocket scale), diameter and length measured by a digital Vernier Caliper (OLENDER electronic carbon fiber digital Vernier Caliper with LED screen), type of material used in manufacturing the instrument was identified by checking the composition in the catalog provided by the manufacturer and effect of surface characteristics of the instrument tested by measuring the coefficient of static friction with a wet gloved finger.

In the subjective evaluation, the participants responded to a query immediately after the completion of the task with each scaling instrument. The query included instrument efficacy on calculus removal, time taken, the number of strokes required for complete removal of calculus, and what instrument design characteristic helped for easy removal of calculus by two different instruments used for scaling.

Supragingival calculus removal procedures are reported to cause painful sensations in the operator's fingers due to the repetitive forces used while performing hand scaling. This study measured the subjective intensity of discomfort of the operators on a verbal rating scale (VRS) during supragingival scaling with Hu-Friedy and LM instruments.

VRS- verbal rating scale

'0' - no pain or discomfort

'1' - mild pain or discomfort or sensitivity

'2' - moderate pain or discomfort or sensitivity

'3' - severe pain, discomfort, or sensitivity that subsides after 5 min of scaling

'4' - severe persistent pain, or radiating pain, discomfort, or sensitivity after the scaling procedure.

The cutting efficacies of scalers were tested after the completion of the study by evaluating the cutting

edge against a plastic test stick. The sharpness of the instruments was checked before and after completion of the study by holding the plastic test stick in the non-dominant hand and the instrument in the dominant hand. Cutting efficacy is tested by evaluating the bite of each type of instrument by placing the cutting edge of the instrument at 70° to 80° angulation to the stick.

The data collected was entered into Microsoft Word (Master chart) and Excel sheet and subjected to the Statistical Package for Social Sciences (SPSS) version 20.0 program (IBM SPSS, IBM Corp., Armonk, NY, USA). The results were evaluated statistically using the following methods:

A comparison of the two different sets of hand instruments was done by using descriptive statistics for all the parameters used to know the handling characteristics and efficacy of instruments in calculus removal.

## RESULTS

A total of 100 sites in 50 patients were included in the study after recording the calculus index-simplified (CI-s). Only the patients with +2/+3 scores of calculus on either side of quadrants were included. The design characteristics of both LM instruments and Hu-Friedy instruments, handling characteristics, and calculus removal efficacy were measured and evaluated, respectively.

In dental work, the design and the material of dental instruments can affect the overall clinical outcome and success of the treatment. Two different sets of hand instruments were tested for the efficacy of calculus removal and their handling characteristics during scaling.

During the scaling procedure, the LM instrument was rated as best (40 out of 50 participants) based on usability features like weight, the diameter of the handle, material, and surface characteristics. The weight of the LM instrument (17.99 grams & 13.7mm) was less when compared to the Hu-Friedy hand scaling instrument (21.74 grams & 9.5 mm), and the diameter of the LM instrument was more (13.7mm) when compared to the Hu-Friedy instrument (6mm). The surface characteristics were enhanced due to the silicone-made handle with a light bodyweight alloyed core in the LM instrument compared to the Hu-Friedy though it has got a large handle with serrations. All the design characteristics of LM and Hu-Friedy hand instruments were tabulated in the following (Table 1).

During the scaling procedure, the operator's responses in frequency and percentages on the handgrip were 43 & 86% for LM instruments and 7 & 14% for Hu-friedy instruments. The operator's responses in frequency and

**Table 1.** Describes the design characteristics of both LM instruments and Hu-Friedy instruments.

Design characteristics	LM Instruments	Hu-Friedy Instruments
Weight	17.99 Grams	21.74 Grams
Length	160 mm/16 cm/6.2 “	165 mm /16.5 cm/6.5”.
Diameter (Ø)	13.7 mm	9.5 mm
Length	110 mm/ 11 cm/ 4.4”	109mm/10.9cm/ 4.3”
Cross-section	Triangular in cross-section	Hollow cylindrical
Material used	Silicone (elastic) handle with light body weight specially alloyed core.	Stainless steel.
Surface characteristics	Non-slip elastic silicone grip, Ergonomic surface material	Large handles with serrations

Lm: LM hand instruments; Hf: Hu-Friedy hand instruments

**Table 2.** Describes the responses and percentages of dental professionals on handling characteristics and treatment efficacy characteristics of two types of hand instruments.

Instrument Handling & Treatment Efficacy Characteristics	Type of Instrument	No. of Responses from the Clinicians	Responses in percentage from the clinicians	The best instrument type chosen
Handgrip	LM instrument	43	86%	LM instrument
	Hu-Friedy	7	14%	
Static friction	LM instrument	45	90%	LM instrument
	Hu-Friedy	5	10%	
Surface characteristics	LM instrument	40	80%	LM instrument
	Hu-Friedy	10	20%	
Time required (≤1min & ≥ 1 min)	LM instrument(≥ 1 min)	31	62%	Hu-Friedy
	Hu-Friedy (≤1min)	19	38%	
No.of Strokes (≤ 60 strokes & ≥ 60 strokes)	LM instrument (≥ 60 strokes)	28	56%	Hu-Friedy
	Hu-Friedy (≤ 60 strokes)	22	44%	
Force (Less & More Pinch forces)	LM instrument (More pinch force)	36	72%	Hu-Friedy
	Hu-Friedy (Less pinch force)	14	28%	
Cutting efficiency after study	LM (Same)	40	80%	LM instrument
	Hf (Reduced)	10	20%	
Sharpness of the instrument after completion of the study	LM instrument (More pinch force)	40	80%	LM instrument
	Hu-Friedy (Less pinch force)	10	20%	
Discomfort to the clinicians	LM instrument (Less discomfort)	40	80%	LM instrument
	Hu-Friedy (more discomfort)	10	20%	
Fatigue to the clinicians	LM instrument (Less fatigue)	40	80%	LM instrument
	Hu-Friedy (more discomfort)	10	20%	

Lm: LM hand instruments; Hf: Hu-Friedy hand instruments



**Table 3.** Verbal rating score for LM instruments and Hu-Friedy instruments.

Type	Verbal rating score (Responses in Number and Frequencies)				
	0	1	2	3	4
LM instruments	10 (20%)	40 (80%)	-	-	-
Hu-Friedy instruments	-	10 (20%)	20 (40%)	20 (40%)	-

Out of ten parameters checked in both handling and efficacy characteristics, LM instruments scored 7 points, whereas Hu-Friedy instruments scored 3 points. Thus, in this study, most of the clinicians chose LM instruments.

percentages on static friction were 45 & 90% for LM instruments and 5 & 10% for Hu-friedy instruments. The operator's responses in frequency and percentages on surface characteristics were 40 & 80% for LM instruments and 10 & 20% for Hu-friedy instruments (Table 2).

Out of 50 participants, 40 dental professionals said that calculus removal was easy with Hu-Friedy instruments. Nineteen among fifty participants took less than a minute for the complete removal of calculus with Hu-Friedy instruments when compared to LM instruments. Twenty-two participants out of 50 members said that they took less than 60 strokes for complete removal calculus on one site with Hu-Friedy instruments. The pinch force required was less with Hu-Friedy instruments (14/50 participants) compared to LM instruments (36/50 participants) during calculus removal (Table 2).

When tested for cutting efficiency of both types of instruments after completing 50 cases, it was reported that 43 participants observed the cutting efficiency of LM instruments remained the same by testing on the plastic kit. The cutting efficiency of Hu-Friedy instruments was slightly reduced when compared initially to the plastic testing kit (Table 2).

The verbal rating score for LM instruments was: out of 50 participants, 40 dental professionals responded that they experienced mild discomfort (score 1) and 10 operators felt no discomfort (score 0) after the calculus removal. The verbal rating score for Hu-Friedy instruments was: out of 50 participants, 10 dental professionals responded that they experienced mild discomfort (score 1), 20 dental professionals responded that they experienced moderate discomfort (score 2), and 20 dental professionals responded that they experienced severe discomfort (score 3), after the calculus removal (Table 3).

## DISCUSSION

Periodontitis is a multifactorial disease associated with the loss of supporting tissues around the tooth. The goal of periodontal therapy is to alter or remove the microbial environment and risk factors for periodontitis to apprehend the disease's progression and maintain the dentition in health and function with appropriate esthetics.<sup>1,2</sup>

Non-surgical periodontal therapy may be done by both hand instruments and power-driven instruments. Hand instruments used for non-surgical periodontal therapy are scalers, chisels, hoes, files, and curettes. Thorough instrumentation will help to create an environment free of plaque, calculus, and microorganisms which further prevents the destructive process of periodontal disease and promotes the health of the patient.<sup>3,4</sup> In this study scaling was done under magnification 3.5x for thorough and complete removal of calculus as it involved 3-4 teeth in a quadrant.<sup>5</sup>

Nowadays, the main focus of the researchers is on how to improve the operator's comfort and work efficiency through instrumentation. To achieve better comfort and efficacy with hand instruments, dental manufacturers have to work out the design of the instruments that facilitate easy handling and efficacy in the treatment.<sup>6</sup> Instrument design characteristics like weight, diameter, length, type of material used in manufacturing the instrument (composition of the alloys used), and surface characteristics will play an important role in modifying the comfort and efficacy of instrumentation.<sup>7</sup>

In this study, two different sets of hand instruments were used to assess the handling characteristics and the efficacy in calculus removal. LM hand instruments namely, Mc Call LM 11 A-12A Scaler and Sickle LM 23 Scaler were compared with Hu-Friedy Universal Scaler SU 15/30 and Posterior Scaler SJ 31/326.

The LM-ErgoSense® handle receives the highest ergonomics rating and is designed with a metal alloy core that is consistent from tip to tip, which aids in tactile sensitivity. The instruments almost feel weightless, making the scaling process much easier without any discomfort or fatigue to the operator's hand, especially for lengthier procedures. In addition to the handle, the LM Sharp Diamond™ instruments have an extremely hard micro-coating that uses physical vapor deposition (PVD) technology to allow the instrument to retain shape, be razor-sharp, and be more wear-resistant.<sup>7</sup>

Hu-Friedy, instruments, are made of unique metal with a textured handle design, to perform at their best while doing dental procedures. Hu-Friedy instruments have



a superior stainless-steel alloy that stays sharper for a longer time and the requirement for sharpening is less. Clinical efficiency and greater productivity are the top characteristic uses of Hu-Friedy for dental practice.<sup>2</sup>

Simmer-Beck M et al. conducted a study on the benefits of ergonomic features of dental hygiene instruments and stated that the length, diameter, and weight of the instrument play an important role in preventing discomfort or fatigue caused by the removal of hard deposits on the teeth. The suggested conclusions were the optimal diameter for dental instruments and mirrors should be at least 10 mm, and the optimal weight should be 15.0 g or less.<sup>8</sup>

Hui Dong et al. in 2007 conducted a study to evaluate the effect of tool handle shape on hand muscle load and pinch force in a simulated dental scaling task. The suggested conclusions were the instrument handle with a tapered, round shape and a 10 mm diameter requires the least muscle load and pinch force when performing simulated periodontal work.<sup>9</sup>

In the present study, the LM instruments were rated as best (80% of participants) based on usability features like weight, the diameter of the handle, the type of material composition, and surface characteristics. The weight of the LM instrument (17.99 grams) was less when compared to the Hu-Friedy hand scaling instrument (21.74 grams) and the diameter of the LM instrument was more (13.7mm) when compared to the Hu-Friedy instrument (9.5mm). Handle design characteristics of scaling instruments affect hand muscle load and pinch force during the scaling procedure. Thus, the instruments with lightweight and larger diameters require the least amount of pinch force during scaling with added comfort and efficacy. The cutting efficiency is good for Hu-friedy instruments initially, and thus they require less pinch force for calculus removal. Whereas the cutting efficiency reduced gradually after completing 50 cases with the same instrument, the pinch force required for scaling was more compared to the initial cases. The cutting efficiency of LM instruments remained constant, and the pinch forces required for calculus removal also remained the same.

In the present study, the surface characteristics were enhanced due to the silicone-made handle with a light bodyweight alloyed core in the LM instrument compared to the Hu-Friedy instrument though it has got a large handle with serrations. Out of all the participants, 80% responded that the surface characteristics of LM instruments helped them in better handling the instruments and easy removal of calculus.

Canakci V et al. in 2003 conducted a study to determine whether successful scaling and root planing (SRP) depends upon the grip used on the periodontal curette.

Instrument grip had a significant effect on response to SRP, suggesting that dentists using a modified pen grasp achieved better clinical results. In the present study, handgrip characteristics were best for LM instruments compared to the Hu-Friedy instruments. Out of all the participants, 86% of them said that LM instruments had better hand grip characteristics.<sup>10</sup>

In the present study, we even tested the efficacy of calculus removal by using two different sets of instruments. Out of 50 participants, 80% of dental professionals said that calculus removal was easy with Hu-Friedy instruments. Among fifty participants 38% of participants took less than a minute for complete removal of calculus with Hu-Friedy instruments when compared to LM instruments. Out of 50 members, 44% of participants said that they took less than 60 strokes for complete removal calculus on one site with Hu-Friedy instruments. The pinch force required was less with Hu-Friedy instruments (14/50 participants) compared to LM instruments (36/50 participants) during calculus removal.

According to Dong H, et al., in 2007 the pinch forces used were greater when compared to the dentists in his study. Students applied high pinch forces to the instrument tools, whereas dentists applied high forces at the instrument tip which were directly related to the efficiency of the scaling procedure. The mean peak pinch force was greater for dental students ( $35.7 \pm 3.8$  N) than dentists ( $24.5 \pm 4.1$  N), suggesting that dental students with less clinical experience apply excessive force during scaling. The mean safety margin was higher for dental students ( $4.88 \pm 1.58$ ) than dentists ( $3.35 \pm 0.55$ ), suggesting that inexperienced students apply excessive force during scaling.<sup>9</sup>

In this current study, we have trained all the interns who were the operators in this research on how to handle two different types of hand instruments for scaling. The mean pinch forces determined during the calibration exercise before starting the study using electromyography was 30 to 36 N. The clinical experience also played an important role in applying fewer pinch forces during scaling procedures by interns. In this study, we have recruited the participants with +2/+3 calculus only on both quadrants for scaling. At the end of the scaling procedures, we asked the operators about which instrument required less force for the removal of calculus. The pinch force required was less with Hu-Friedy instruments compared to LM instruments.<sup>11,12</sup>

It was interesting that, though the handling characteristics like hand grip, static friction, and surface texture characteristics were best for the LM instruments, the efficacy in calculus removal, time taken for complete removal of calculus, and the number of strokes required for complete removal of the calculus

was best with Hu-Friedy instruments.<sup>11,12</sup> When tested for the cutting efficiency of both types of instruments after completion of the study, the cutting efficiency of Hu-Friedy instruments was slightly reduced when compared with LM instruments on the plastic testing kit.<sup>13-15</sup>

The split-mouth design of the current study is ideal for evaluating the two different sets of hand instruments for handling characteristics and efficacy in calculus removal responses. The comfort in handling the LM instruments showed best compared to Hu-Friedy instruments. Though the efficacy in calculus removal showed best for Hu-Friedy instruments initially, at the end of the study, the cutting efficiency was reduced for Hu-Friedy instruments. This study provided substantial evidence for choosing LM instruments over Hu-Friedy instruments because of better handling characteristics and the retention of cutting efficiency even after scaling for fifty cases. Though the cutting efficiency is good and took less time and a smaller number of strokes for calculus removal, the sharpness of the Hu-Friedy instruments and the reduction in cutting efficiency made us choose LM instruments.

In this study, when measuring the subjective intensity of discomfort and fatigue on a VRS during supragingival scaling with LM instruments and Hu-Friedy instruments, 80% of participants responded that there was less discomfort and fatigue when using LM instruments for scaling.

Limitations of the present study include the sample size was small, and hence results cannot be generalized to the entire population, and no instruments have all the better characteristics like the ease of handling, cutting efficiency, and ease of calculus removal altogether in one set.

Future directions include long-term multicenter randomized controlled studies with a larger sample size required to prove the efficacy of two sets of hand instruments. The combination of the best handling characteristics and ease of calculus removal with static cutting efficiency in every instrument should be an innovative task for all dental instrument manufacturers and researchers for better treatment outcomes.

## CONCLUSION

Instrument designs like weight, the diameter of the handle, and length of the instrument play an important role in the efficacy of calculus removal. Therefore, a lighter instrument bearing a wider handle is ideal. Handling characteristics like hand grip, static friction, and the surface texture of the instrument depend on the design and type of material used to

manufacture dental instruments. An instrument with a better handgrip and static friction is also imperative to instrumentation. When the instrument design and handling characteristics are better, the ease and efficacy in non-surgical treatment like scaling will be better with comfort and without any fatigue to the clinician. So, it can be concluded that selecting the best instrument with the best design, good handling characteristics with static cutting efficiency will result in better treatment outcomes in less time and with less discomfort or fatigue to the operator.

## ACKNOWLEDGEMENT

We thank Dr YSR University of Health Sciences for giving us the opportunity to conduct the undergraduate student research project. We were also grateful to Vishnu Dental College for providing the facilities to complete the research.

## CONFLICT OF INTEREST

The authors declare that they have no conflict of interest in publishing the article.

## FUNDING

The authors declare that they have no funding related to this research project.

## REFERENCES

1. Kumar PM, Sahitya S, Penmetsa GS, Supraja S, Kengadaran S, Chaitanya A. Assessment of knowledge, attitude, and practice related to ergonomics among the students of three different dental schools in India: An original research. *J Educ Health Promot.* 2020; 9:266.
2. Narukurthi H, Pasupuleti MK, Penmetsa GS, Sruthima NG, Ramesh K, Vinnakota K, Sravanthi V, Gera D. Comparison of non surgical periodontal treatment outcome and clinician's comfort levels using LM ErgoMax over Hu-Friedy Hand Instruments-A randomised clinical trial. *J Clin Diagn Res.* 2023; 17(2):ZC46-51.
3. Puglisi R, Santos A, Pujol A, Ferrari M, Nart J, Pascual A. Clinical comparison of instrumentation systems for periodontal debridement: A randomized clinical trial. *Int J Dent Hyg.* 2022; 20(2):328-38.
4. Rempel D, Lee DL, Dawson K, Loomer P. The effects of periodontal curette handle weight and diameter on arm pain: A four-month randomized controlled trial. *J Am Dent Assoc.* 2012;

- 143(10):1105-13.
5. Cobb CM. Clinical significance of non-surgical periodontal therapy: An evidence-based perspective of scaling and root planing. *J Clin Periodontol.* 2002; 29 Suppl 2:6-16.
6. Yan Y, Zhan Y, Wang X, Hou J. Clinical evaluation of ultrasonic subgingival debridement versus ultrasonic subgingival scaling combined with manual root planing in the treatment of periodontitis: study protocol for a randomized controlled trial. *Trials.* 2020; 21(1):113.
7. *Pioneers in Instrument* [Internet]. Parainen: LM-Dental™; c2023 [cited 2022 Sep 10]. Available from: <https://lm-dental.com/en-us/about-us/company/>
8. Simmer-Beck M, Branson BG. An evidence-based review of ergonomic features of dental hygiene instruments. *Work.* 2010; 35(4):477-85.
9. Dong H, Loomer P, Barr A, Laroche C, Young E, Rempel D. The effect of tool handle shape on hand muscle load and pinch force in a simulated dental scaling task. *Appl Ergon.* 2007; 38(5):525-31.
10. Canakci V, Orbak R, Tezel A, Canakci CF. Influence of different periodontal curette grips on the outcome of mechanical non-surgical therapy. *Int Dent J.* 2003; 53(3):153-8.
11. Dahiya P, Kamal R. Rotary instruments in the treatment of chronic periodontitis: A randomized clinical trial. *J Indian Soc Periodontol.* 2013; 17(6):748-52.
12. Kamath DG, Umesh Nayak S. Detection, removal and prevention of calculus: Literature Review. *Saudi Dent J.* 2014; 26(1):7-13.
13. Mittal A, Nichani AS, Venugopal R, Rajani V. The effect of various ultrasonic and hand instruments on the root surfaces of human single rooted teeth: A Planimetric and Profilometric study. *J Indian Soc Periodontol.* 2014; 18(6):710-7.
14. Marda P, Prakash S, Devaraj CG, Vastardis S. A comparison of root surface instrumentation using manual, ultrasonic and rotary instruments: An in vitro study using scanning electron microscopy. *Indian J Dent Res.* 2012; 23(2):164-70.
15. Ioannou I, Dimitriadis N, Papadimitriou K, Sakellari D, Vouros I, Konstantinidis A. Hand instrumentation versus ultrasonic debridement in the treatment of chronic periodontitis: A randomized clinical and microbiological trial. *J Clin Periodontol.* 2009; 36(2):132-41.

(Received April 15, 2023; Accepted November 12, 2023)