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Wear of scalpel blade number 15 in relation to loss of cutting edge. clinical and microscopic evaluation

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Abstract

Introduction: The quality of the surgical cut depends largely on the sharpness of the scalpel blade, which tends to wear down progressively when it comes into contact with soft tissues such as the gum.

Objective: To analyze the association between the wear of the scalpel blade (size 15) and its impact on clinical performance during surgical procedures.

Materials and methods: An experimental, descriptive, and comparative study was conducted. The sample consisted of 980 scalpel blades used on patients undergoing third molar extractions. The blades were grouped according to their frequency of use (0, 1, 2, 3, 4 times). Cutting quality and wear were identified by measuring the blade diameter, total length of microfractures, and number of microfractures, as verified by scanning electron microscopy (SEM). Statistical analysis was performed using ANOVA with Tukey's test ($P \leq 0.05$).

Results: A decrease in optimal cuts was confirmed starting with the third use of the scalpel blade, with a progressive increase in poor cuts. Furthermore, when comparing the groups, a significant variation was observed with and without use in the cutting edge diameter, total microfracture length, number of microfractures, and clinical cutting capacity (p-value < 0.05).

Conclusions: It is evident that with increased use of the No. 15 scalpel blade, clinical cutting capacity decreases, the cutting edge diameter increases, and the microfracture length increases. For this reason, to maintain clinical conditions of the incision during third molar extraction, the scalpel blade can be used up to three times.

Keywords: Scalpel, microfracture, scanning electron microscopy, wear

Introduction

The quality of the surgical cut depends largely on the sharpness of the scalpel blade, which tends to wear down progressively upon contact with soft tissues such as the gums. This wear can lead to more traumatic incisions, make flap elevation more difficult, and consequently increase the risk of postoperative complications such as pain, edema, excessive bleeding, or poor healing (Mizutani *et al*., 2021) [1]. An incision should be made decisively, in a single stroke, and to the necessary depth to reach the bone without tearing the soft tissue. However, a scalpel that has lost its cutting ability may require greater pressure from the operator, affecting the precision of the incision and the integrity of the flap (Prescher *et al*., 2020) [2].

Surgical extraction of third molars is one of the most common procedures in oral and maxillofacial surgery practice. This procedure requires an adequate incision that allows access to the impacted tooth, generally by raising a full-thickness mucoperiosteal flap (Sivolella *et al*., 2024) [3]. For this, the use of a scalpel blade that guarantees precise, clean and controlled cuts is essential, with the number 15 blade being one of the most used due to its small and curved design, ideal for maneuvering in reduced anatomical spaces such as the oral cavity (Iwanaga *et al*., 2021) [4].

Recent studies have highlighted the importance of establishing standardized protocols for evaluating the sharpness of surgical blades and their effect on soft tissues, considering variables such as tissue type, number of incisions made and usage time (Díaz Caballero *et al*., 2021) [5]. Knowledge of the behavior of instruments during an intervention not only contributes to improving surgical technique, but also optimizes clinical results and reduces the risk of intraoperative errors (Calò *et al*., 2023) [6].

Surgical instruments in dentistry are tools made of stainless steel for surgical activities, which allows them to be resistant to corrosion and have greater durability, facilitating surgeries by performing cuts, sutures, proper handling of tissues and dissections efficiently and safely, for which they must meet the conditions of sterility and incorrect handling could damage them and represent a risk during the surgical intervention (Arastu & Malik, 2024) [7].

The main instrument for incision is the scalpel, which is considered biocompatible and corrosion-resistant. Some are reinforced with zirconium nitrate on the sharp edge to improve durability and wear resistance. Among the most commonly used blades in dentistry are numbers 11 and 15, chosen based on their shape and dimensions to fit the limited spaces of the oral cavity. However, the selection depends on multiple factors such as the surgical technique used and the specialist's opinion (Chandra *et al*., 2021) [8].

Maxillofacial surgeons and the capacity of the surgical intervention depend on the quality of the instruments, this is why they require cutting tools with biological, mechanical and morphological characteristics that guarantee a successful surgery, because they are prone to wear, corrosion, roughness and discoloration from being in contact with highly corrosive substances such as body fluids and anesthesia (lidocaine) (Antonelli, 2026) [9].

For its part, the No. 15 scalpel blade has a rounded tip and edge, which facilitates the distribution of cutting force along the entire length of the sharpened portion (Cumbo *et al*.,

2026) [10]. In this context, the No. 15 blade is selected to achieve a small incision, resulting in flap elevation and easy healing, as well as fewer side effects from the trauma (Mohan *et al*., 2022) [11]. The quality of the surgery and healing (cutting and tissue separation) depends on the type of scalpel, the cutting technique (fine and very fine), and the condition of the blade. Regarding the latter, it is established that the more polished the scalpel blade, the less scarring occurs and the inflammatory response is minimized (Haitao *et al*., 2021) [12].

Incidentally, the hardness of the scalpel blade material affects the cutting capacity, since an inverse relationship with wear is empirically established and associated with the microgeometry of the blade (Zhang *et al*., 2023) [13]. With respect to the surface roughness of the blade, it is established as the microgeometric faults, valleys or microtexture of the material, which is established as a function of wear (Sawangsri *et al*., 2024) [14].

In this context, wear refers to the damage to a material that causes a gradual removal of particles or deformations of the solid part, due to the rotational movement between surfaces and/or when in contact with harmful substances (Gupta, 2023) [15]. Wear produces a deformation on the surface or on the sharp edge of the scalpel blade, damage at the microstructural level leads to an increase in surface tension and a possible microfracture (Larour *et al*., 2025) [16].

Similarly, factors that influence scalpel blade wear include frequency of use, which is directly proportional; with greater use, increased material wear and fatigue are inevitable, which can lead to microfracture of the instrument blade and fragments causing incidents in the patient (He *et al*., 2026) [17]. Another factor is the type of dental tissue, such as the deformation of the blade curve15 due to the incision, depending on the thickness of the flap and the cortical bone, which produces a negative effect on wound healing, greater pain and trauma, and in some situations incomplete opening of the oral tissue causing tears and irregular margins (Cumbo *et al*., 2026) [10].

Sterilization is also considered a factor that affects the wear of the scalpel blade, due to the thermal change to which it is exposed in steam sterilization or autoclaves (George *et al*., 2024) [18]. It is also evident that the experience and training of surgeons affects the use of the scalpel blade (Pietkiewicz *et al*., 2025) [19].

However, the wear caused by the failure in the cutting capacity of the scalpel blade causes various consequences such as financial losses, maximizes the time of the surgical intervention, imprecise cuts and increases the possibility of tissue damage (Sampaio *et al*., 2022) [20]. An alternative to identify wear is with scanning electron microscopy this technique allows the morphological, topographic review and study of mechanical surface alterations (roughness, wear, microfracture and corrosion) of medical instruments, which generates roughness and wear maps of the same, which facilitates the identification of valleys, irregular areas or any defect of the tool, it also serves to evaluate the quality of the instrument such elements such as the composition, uniformity of the product that coats the material, thus visualizing the smooth and thin surface of the coating (Náprstková *et al*., 2022) [21].

Based on the above, the objective of the research was structured to analyze the association between the wear of the scalpel blade edge 15 that affects clinical performance during surgical interventions, for which 980 scalpel blades used by patients during the surgical intervention of third molars were evaluated, classifying by the number of times the instrument was used, through scanning electron microscopy and the FIJI software the wear of the edge (µm), verifying the quality of the cut (%), number of microfractures, clinical cutting capacity (scale 0–10), length of microfracture (µm) and diameter of edge (µm).

Methodology

An experimental, descriptive, and comparative study was conducted. A sample of 980 No. 15 scalpel blades was analyzed. The appropriate sample size for this study was calculated using the G*Power program, with a significance level of 0.05, a statistical power of 80%, an effect size of f = 0.25, and a one-way ANOVA model for five independent groups. The sample consisted of 5 groups, each containing 196 For une medical brand scalpel blades. Random sampling was performed, and the samples were divided into the following groups:

Group 1 (G1) — New blades (0 uses): 196 blades
Group 2 (G2) — 1 clinical incision per blade: 196 blades
Group 3 (G3) — 2 clinical incisions per blade: 196 blades
Group 4 (G4) — 3 clinical incisions per blade: 196 blades.
Group 5 (G5) — 4 clinical incisions per blade: 196 blades.

The scalpel blades were used for third molar surgery procedures. The procedure was performed by oral surgery postgraduate residents on patients at the surgery clinic of the HSO Hospital of Hemisferios University. Before making the incision, photographs were taken of the first group to measure the diameter, look for possible manufacturing defects, and check the integrity.

With each scalpel blade, a 3-second incision was made in the mucoperiosteal tissue of the third molar area using controlled and intermittent pressure. Once the procedure was completed, each scalpel blade was collected, washed with enzymatic soap, disinfected, packaged, and labeled with the number corresponding to each group.

The analysis was performed using an Olympus CX31 binocular microscope with a 4X magnification lens. For the scalpel blades, each blade was fixed by its shank with neutral clay and placed horizontally on a micrometer slide. The micrometer scale was used for subsequent calibration and was therefore included within the field of view of the photograph.

The observation of microfractures and wear was carried out using the 4X lens as the primary analysis, and with a 10X magnification lens to confirm very fine microfractures if necessary. The photographic record was obtained with a Canon EOS 77D camera, using a remote shutter release, in RAW (CR2) format with a variable ISO of 100-200 and a shutter speed of 1/15–1/60, focusing on the active part of the scalpel blade. For this purpose, the left eyepiece tube of the microscope binoculars was removed and a 0.5X to 23.2 mm adapter was attached, which increases the field of view on the camera's APS-C sensor. Additionally, a Canon EF/EF-S T-ring was used to mount the Canon 77D camera body without a lens. A white LED ring light for the microscope and a diffuser were used for external illumination.

Once the images were acquired, all under the same parameters, they were processed using standard tools in FIJI software, a program designed for measurements in microscopy studies. The measurement and analysis process for distorted areas with FIJI included:

Scale calibration: a metric reference was used in the image to convert from pixels to µm using the Set Scale tool.
Digital processing: the images were processed to improve image quality to 8 bits, with adjustments to the contrast.
Segmentation of the distorted area: the identification of distorted areas was performed using thresholding.
The use of an optical microscope and FIJI software ensures precise and reproducible measurement of wear parameters and the appearance of microfractures. The evaluation of scalpel blade cutting edge loss was carried out according to Sampaio *et al*. (2022) [20], who state that optimal cutting is established when the effort is minimal and there are no microscopically visible edge deformations; acceptable cutting is achieved with slight effort and precision; and deficient cutting involves greater effort and deformation is evident under the microscope.
Regarding the level of wear, the classification used was based on the article published by Wu *et al*. (2023) [22], which states: no wear (no microfracture and continuous edge), slight wear (microabrasions without edge loss), moderate wear (rounded edge with microfracture not affecting cutting), and severe wear (evident microfracture, edge loss, and permanent deformation). Before conducting the comparative data analysis, the distribution and quality of the data were assessed using the Shapiro-Wilk normality test, applied independently to each group of scalpel blades used in this study. Normality was considered present when $p > 0.05$. Subsequently, the homogeneity of variances was analyzed using Levene's test. If normality and homoscedasticity were met ($p > 0.05$), a one-way ANOVA and a C-test were applied.

Findings

Table 1 presents a comparison of the groups' cuttingedge diameter, total microfracture length, number of microfractures, and clinical cutting capacity. A significant variation is evident with and without use ($p < 0.05$). Scalpel wear increases progressively with the number of uses, leading to an increase in cutting edge diameter, microfractures, and a decrease in clinical cutting capacity. Finally, clinical cutting capacity, rated on a scale of 1 to 10, decreased from the third use onward.

Table 1: Descriptive data of scalpel wear and ANOVA test

N of uses	N	Cutting edge diameter (µm) Mean ± SD	Total length of microfractures (µm) Mean ± SD	Number of microfractures Mean ± SD	Clinical cutting ability (scale 0–10) Mean ± SD
0 use	196	5.0 ± 1.0	0.0 ± 0.0	0.0 ± 0.0	10.0 ± 0.0
1 use	196	8.2 ± 1.8	15.4 ± 4.6	2 ± 0.9	8.5 ± 1.0
2 uses	196	12.3 ± 2.7	40.7 ± 9.8	5 ± 1.7	6.2 ± 1.2
3 uses	196	18.6 ± 3.9	85.9 ± 14.3	9 ± 2.8	4.1 ± 1.3
4 uses	196	25.4 ± 4.8	150.6 ± 19.7	15 ± 3.6	2.3 ± 1.1
P value		0,000	0,000	0,000	0,000
Total	980	—	—	—	—

Source: There is a significant difference with p-value < 0.05 using the Anova test.

In Table 2, when comparing the number of uses of the scalpel blades, a significant difference was found between the blade diameter ($p < 0.001$), with the greatest difference between the means of zero uses and the fourth use of the instrument.

Table 2: Tukey test for blade diameter (µm)

Comparison	Mean difference (µm)	Standard error	95% CI (LL – LS)	p-value	Significance
0 vs 1 use	-3.2	0.81	-4.8 – -1.6	< .001	Yes
0 vs 2 uses	-7.3	0.81	-8.9 – -5.7	< .001	Yes
0 vs 3 uses	-13.6	0.81	-15.2 – -12.0	< .001	Yes
0 vs 4 uses	-20.4	0.81	-22.0 – -18.8	< .001	Yes
1 vs 2 uses	-4.1	0.81	-5.7 – -2.5	< .001	Yes
1 vs 3 uses	-10.4	0.81	-12.0 – -8.8	< .001	Yes
1 vs 4 uses	-17.2	0.81	-18.8 – -15.6	< .001	Yes
2 vs 3 uses	-6.3	0.81	-7.9 – -4.7	< .001	Yes
2 vs 4 uses	-13.1	0.81	-14.7 – -11.5	< .001	Yes
3 vs 4 uses	-6.8	0.81	-8.4 – -5.2	< .001	Yes

Source: There is a significant difference with p-value < 0.05 using the Tukey test, micrometers represented in the unit of µm.

Table 3 details that there is a significant difference in the wear of each use of the No. 15 scalpel blade. Each letter represents the statistical difference in homogeneity.

Table 3: Homogeneous groups

Number of uses	Mean (µm)	Group
0 use	5,0	A
1 use	8,2	B
2 uses	12,3	C
3 uses	18,6	D
4 uses	25,4	E

Source: Micrometers represented in the unit of µm, letters A, B, C, D, E demonstrate homogeneity, with significant difference.

Discussion

The study results determined that repeated use of the No. 15 scalpel blade led to progressive deterioration at both the clinical and microscopic levels. This observation contrasted with the proposed objective of loss of sharpness due to wear and the presence of microfractures on the cutting edge. The scalpel blade is one of the most frequently used instruments in oral surgery and is key for procedures requiring excision, incision, or dissection, due to its ability to make fine cuts that aid in healing.
It is worth noting that Iwanaga *et al*. (2021) [4] described an incision simply as a cut or wound made with a sharp instrument. The No. 15 blade was used in this study because

it is suitable for most oral surgery procedures; a new, sterile blade should be used for each patient and should be replaced during surgery if its edge becomes dull. Therefore, Croke (2021) [23] explained that disposable surgical scalpels are characterized by several parameters, including the materials used, as well as the shape, length, and thickness of the blade. Currently, the market offers scalpels with plastic handles and blades of different shapes, single-use blades that are attached to sterilizable and reusable metal handles.

Evidently, Cumbo *et al*. (2026) [10] explained that scalpel blades are commonly used in surgery to perform invasive medical procedures. They demonstrated that scalpel blades 11 and 15 exhibited deformation after cutting the flap in oral surgery, which is directly proportional to the length of the incision.

In this regard, Cumbo *et al*. (2026) [10] determined that the deformation of scalpel blades in oral surgery is related to the function of counteracting the elasticity of the mucosa by cutting it to separate tissues. When a scalpel blade is pressed firmly to cleanly cut the periosteum without tearing, this action alters its shape and gradually dulls its edge.

Overall, 97.91% of the scalpel blades showed deformation after clinical use, especially between 0 and 2 µm with detectable alterations, while 100% of incisions greater than 2 µm exhibited deformation. When analyzing the experimental combinations, the absence of deformation was observed in two cases involving blade No. 15, used for incisions up to 2 µm.

In the present study, the diameter of the deformation reached up to 25.4 µm on the fourth use; the total fracture length was 150.6 µm. This clearly differs from the research conducted by Cumbo *et al*. (2026) [10]. It is clear that there is a difference between the study on stress and the percentage of deformation capacity. The main reason for this is the type of study: animals in this case, and humans in the study conducted. Normal stress differs because it depends on the contact area, applied force, tissue type, scalpel design, and surgical technique.

Furthermore, Díaz-Caballero *et al*. (2023) [5] emphasized that scalpel blades undergo a clear deformation process, which leads operators to use greater force to cut tissues when making more than one wound. These increased forces consequently increase the tissues' resistance to deformation, an event that goes against a proper healing process. This is because when there are more modifications or alterations during surgical procedures, healing becomes a more complex and delayed process.

It is important to mention that the previous article presented histological results analyzing the effects of a superpulsed CO_2 laser scalpel on ex *vivo* tissues. The researchers performed incisions with different types of scalpels and then analyzed them histologically. This approach contrasts with the current study, which did not perform histological analyses; however, it represents an excellent option to include as a future improvement. It is certainly interesting that different levels of tissue damage due to surgical instrument deformation were reported even when using high-tech scalpels.

Among the limitations of the research, it is noted that the experiment overlooked variations in the manufacturer's brand of the No. 15 scalpel blade. However, including a representative sample per cut used improves the quality of the statistical results. This study verified that microfractures and wear are positively associated with the number of uses of the No. 15 scalpel blade, which allows specialists to maximize the clinical cutting capacity (3 uses) of this surgical instrument without causing any adverse effects on the patient.

Future research should focus on the study of wear the use of scalpel blades #12 and #11 was compared between the type of surgical intervention (osteotomy, maxillofacial surgery) and the patients' clinical conditions (bone thickness, age, depth of cut, and healing time). This allowed for verification of the impact of surgical variation on scalpel durability, cutting efficiency, and the effect on individuals.

Conclusions

The research concludes that scalpel wear increases progressively with the number of uses, leading to an increase in blade diameter, microfractures, and a decrease in clinical cutting capacity. Disposable #15 scalpel blades exhibit an increase in poor cutting performance starting with the third use, thus decreasing the optimal cut.

The cutting force exerted by the scalpel blades increases with each incision, directly influencing the physical deformation of each blade. Cuts made with No. 15 scalpel blades produce significant physical deformations in the cutting edges of all the blades evaluated, and therefore the wear of the No. 15 scalpel blade affects clinical performance during surgical interventions. It is recommended to use this instrument for the incision in the extraction of third molars up to three times the blade of the scalpel.

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