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Novel Microscalpels for Removing Proximal Composite Resin Overhangs on Class II Restorations

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Clinical Relevance

Microscalpels and scalpel numbers 12 and 15 can be efficiently used to remove excess composite material in accessible interproximal areas. Scalpels seem to be able to cut composite resin in a material-specific manner without damaging tooth surfaces or resin material surfaces.

SUMMARY

Introduction: Limited access to interdental spaces complicates removal of excess material when placing class II composite resin restorations. Evidence-based recommendations on interproximal finishing are rare. We present novel microscalpels for this indication. The aim of the study was to test their fracture strength and cutting ability and to compare microscalpels with the use of a scaler, oscillating devices (G5-ProShape, G5-Proxocare), finishing strips and scalpels of sizes 12, 15, and 21 in a standardized *in vitro* model.

Methods and Materials: Fracture strength (LOAD) and cutting forces (CUT) of microscalpels were evaluated at different angles (15, 30, 60, and 75 degrees; n=30 each) in a universal testing machine. Devices were compared *in vitro* using standardized composite overhangs. Marginal quality (QUAL; n=30) and quantity of excess/deficit (QUAN; n=30) were evaluated using scanning electron microscopy (SEM) for each device (explorative data analysis, Student *t*-test or analysis of variance; *post hoc* Scheffé).

Results: Microscalpels showed the highest LOAD (95.8 [5.0] N) (mean [standard deviation]) and easiest cutting (CUT) (7.6 [1.5]) at 15 degrees. At all angles, LOAD was significantly higher than CUT ($p<0.001$). Perfect margins were seen most often with scalpel size 12 (QUAL: 37% relative frequency), while most excess (73.4%) was observed with finishing strips. QUAN was lowest with microscalpels (19.3 [4.4] μm) and highest with finishing strips (116.0 [18.8]). Use of scalers led to fractures and crack formation.

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Conclusion: Microscalpels are able to cut composite at a lower force than necessary to fracture the blades at all angles. Small and/or curved scalpels yield the best-quality margins.

INTRODUCTION

Currently, posterior composite resin restorations are widespread treatment options for all cavity sizes. They show good survival when patient, operator, and material parameters are considered adequately.[1-5] Previous limitations in bonding techniques have long been overcome, and even proximal contacts can be adequately reconstructed with novel types of sectional matrices applied with separation rings.[6-8] Concerning layering techniques, elaborate concepts have been presented,[9] while with regard to finishing and polishing, experimental and case reports and descriptions of technical procedures are available.[10-16]

However, the description of finishing procedures focuses mainly on easily accessible surfaces[10] and easily accessible cavity classes (class V[17]), whereas the finishing of proximal surfaces is not specified at all. In general, instruments recommended for marginal finishing are, for example, fine or ultrafine finishing diamonds, which seem to be superior to carbide finishing burs.[15] Even the polishing direction of instruments has been tested and is reported to be superior when moved from the restoration to the tooth surface.[18] Yet those techniques and instruments are not suitable for the interproximal area or are applicable only under extremely limited circumstances.

The lack of interproximal polishing approaches is becoming a more profound problem when looking at the fact that class II composite resin restorations carry a distinct risk of having proximal overhangs.[19] Such proximal overhangs can irritate the periodontium and jeopardize periodontal health.[20-28] Opdam and others[29] reported that up to 43% of margins were overfilled in class II composite resin restorations. Further, overfilled or overhanging margins can also be seen with various other insertion techniques and matrix systems.[29-33] Very early reports on proximal finishing recommended the application of burs, stones, and flexible finishing strips and discs,[16] oscillating devices (eg, Roto-Pro and EVA), and sonic and ultrasonic devices (eg, Cavitron and Sonic Scaler).[34,35] Since those early publications, no novel or innovative instruments for interproximal excess removal have been developed or tested. To address this shortcoming, it is believed that there is great potential in dental scalpels, which are available in various shapes and sizes. At present, their main field of use is in surgery, and they remain of minor importance in restorative dentistry. The use of a scalpel with blade number 12 has already been reported to be helpful for the removal of composite resin excess after adhesive cementation of ceramic blocks.[36] In addition, Morgan and others[37] reported the use of blade number 12 for removing excess composite from the proximal area. Very recently, Kup and others[38] described the use of scalpel number 15 in shaping composite resin as a "material-selective" and "tooth-friendly" way to finish dental composites in anterior teeth. A critical review from our group described the application of scalpel number 12 in the course of a novel two-step application technique for subgingival composite resin restorations.[39] There are increasing data suggesting that blades numbers 12 and 15 are especially suitable for material-selective shaping and finishing of composite resin restorations. Having gained clinical experience with scalpels over many years, our research team had the idea of further reducing the size of the scalpel blades used. Inspiration came from microscalpels, which are used in ophthalmological microsurgery. In collaboration with a company (Trinon Titanium GmbH, Karlsruhe, Germany), a prototype microscalpel (Figure 1) was developed in our department. The delicate blade appeared promising with regard to interproximal accessibility and excess removal efficiency. However, it remained to be ascertained whether the small blade could withstand the high working forces necessary to cut composite resin material without fracturing. This research question was the first aim of our study.

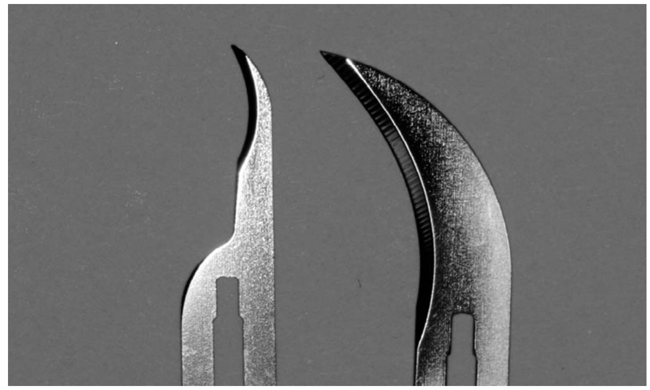

Figure 1. *Microscalpel (left) and scalpel number 12 (right).*

The second aim was to compare traditional proximal finishing devices competitively with the novel device to see if it provides any superior benefit. After screening the literature, it was decided to include plastic flexible finishing strips, oscillating polishing devices, standard scalpels (numbers 12, 15, and 21), and a scaler.

A brief rationale for this choice is presented next. Abrasive finishing strips are recommended in state-of-the-art textbooks and reviews.[40-42] However, these are not capable of reaching concavities of the proximal tooth surfaces due to a "bridging effect." In spite of this, it was included since they are easy to use and widespread. The oscillating polishing device G5-ProxoCare (SDC Switzerland SA, Grancia, Switzerland) was also included in the study. This is similar to the EVA system (KaVo Dental GmbH, Biberach an der Riss, Germany),[34,35] with both the G5-ProxoCare and the EVA system being powered by air pressure, which induces oscillation of a polishing file at the instrument's head.[43] The polishing files are delicate and abrasive on only one side, allowing for comparatively good access to the interdental space without damaging the neighboring tooth surface. The second oscillating device G5-ProShape (SDC Switzerland) was originally introduced as an instrument for orthodontic enamel slicing. It is composed of a metal finishing strip fixed to a plastic frame holder. Its efficient enamel removal prompted the manufacturer to extend the indication to interproximal removal of excess restorative material, and consequently it was included in the present investigation. Scalers are designed for the removal of calculus and plaque from tooth surfaces. Being a hand instrument used in prophylaxis and periodontal treatment, they provide ergonomic handling and good accessibility into interdental spaces even in the farthest posterior locations. Therefore, they have proven convenient to use for the removal of excess bonding material in restorative dentistry.[44-46] The choice of scalpel numbers 12 and 15 is based on literature reports[36-38] and personal clinical experience.[39] Scalpel number 21 is a comparatively large blade not primarily suitable for interdental working and acted as a kind of negative control in our setting.

The following research questions were raised and addressed by this experimental study:

1. Are novel microscalpels safe to use without the risk of fracture?
2. Is there any superior instrument for removing composite resin excess in the interproximal area?

METHODS AND MATERIALS

To answer the first research question, the maximum load strength (LOAD) and cutting ability (CUT) of microscalpels used at different working angles were investigated.

Table 1: *Instruments Tested in the Study*

Instrument	Manufacturer
Scaler S204S7	Hu-friedy Mfg Co, LLC, Tuttlingen, Germany
G5-ProShape grey (60 μm)[a]	SDC Switzerland SA, Bioggio, Switzerland
G5-Proxocare 1760 (60 μm)	SDC Switzerland
Scalpel blade number 12	Feather, Osaka, Japan
Scalpel blade number 15	Feather
Scalpel blade number 21	Feather
SofLex Finishing Strips (Coarse[b])	3M ESPE, Seefeld, Germany
Microscalpel[a]	Trinon Titanium GmbH, Karlsruhe, Germany

[a] *Prototype.*
[b] *No further specification of grit by manufacturer.*

To address the second research question, traditional instruments for proximal excess removal (Table 1) were compared with microscalpels in an *in vitro* model on standardized composite overhangs. Marginal quality (QUAL) and quantity of excess or deficit (QUAN) were evaluated.

LOAD Testing

In clinical use, instruments can be used at different angles on tooth surfaces, requiring the application of gradual forces. To simulate a clinical procedure, microscalpels were tested at four different angles (15, 30, 60, and 75 degrees). The test specimens were made from Eppendorf tubes with aluminum rods polymerized with composite resin perpendicular to the tube axis (Figure 2). Scalpel holders were fixed to a universal testing machine (Zwicki1120, Zwick GmbH & Co, Ulm, Germany) at each of the four angles tested. To test the maximum load, the scalpel was moved up steadily (10 mm/min) parallel to the tube axis toward the aluminum rod until fracture. The maximum load at fracture was displayed in a load/time graph over 90 seconds, and the maximum force was determined as LOAD (N). At each angle, the measurements were repeated 30 times.

CUT Testing

The angle influences the cutting ability of the blade. To test these forces, the same experimental setup was used. Here, specimens were composed of Eppendorf tubes with standardized composite resin overhangs of 150 μm (TetricEvoCeram, Ivoclar Vivadent, Schaan, Liechtenstein), which were fabri-

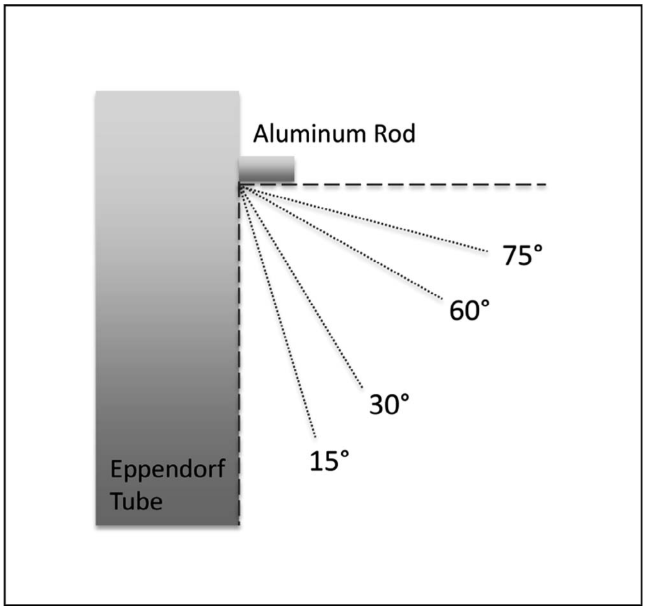

Figure 2. *Schematic diagram of the experimental setup for LOAD testing. The scalpel blade was moved steadily up to the aluminum rod with a velocity of 10 mm/min until fracture.*

cated in a standardized manner using a molding frame. The test procedure was run similarly as described above at all four angles (n=30 measurements per angle). The maximum force necessary to cut the composite resin overhang was displayed in a load/time graph over 90 seconds and determined to be CUT (N).

QUAL/QUAN Experimental Setup

Eight devices for interdental excess removal were tested (Table 1). One hundred and twenty extracted caries- and restoration-free human molars were used to fabricate *ex vivo* models. Teeth were cleaned and optically screened (magnification 2.3×, dental magnification loupes) for cracks, fissures, or flaws in the proximal surfaces. Teeth were stored in 50% ethanol solution until use. They were then randomly distributed into eight groups (n=15 per group) providing a total of up to 30 restorations (mesial and distal sides of the tooth) per group. Human and artificial teeth (Frasaco GmbH, Tettnang, Germany) were set in 120 models simulating rows of teeth. The models allowed for fixation in a phantom head of a dental simulation unit, thus making the application of the test instruments clinically more realistic. For the standardized cavity preparation, we used sonic preparation devices (Sonic Sys 3, SONICflex prepgold, KaVo Dental). The proximal preparation margins were located within the enamel. Proximal composite resin overhangs of 150 μm (mesio-distal thickness) were

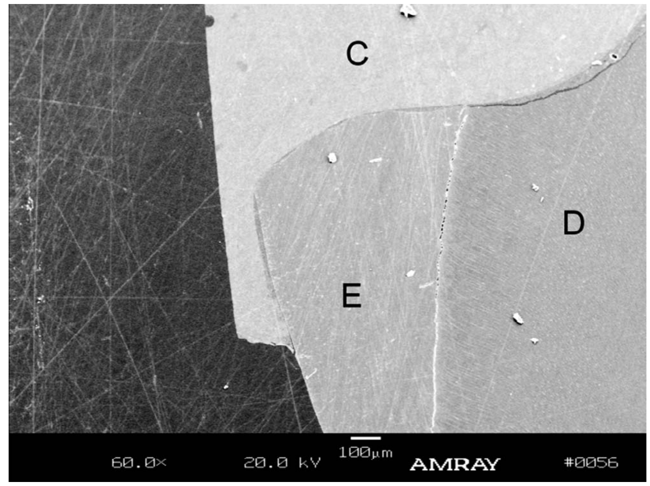

Figure 3. *SEM image of the standardized composite resin overhang of 150 μm (E, enamel; D, dentin; C, composite resin restoration).*

created by applying three layers of metal matrix band (Tofflemire, Kerr, Raststatt, Germany, thickness 50 μm) to maintain the distance between the circumferential matrix band and the proximal tooth surface cervical to the proximal cavity margin. With this technique, we were able to produce standardized overhangs similar to those resulting from insufficiently wedged matrices (Figure 3). Cavities were etched (Email Preparator, Ivoclar Vivadent, 30 seconds enamel, 15 seconds dentin) and treated with the adhesive system according to the manufacturer's instructions (OptiBond FL, Kerr Hawe, Bioggio, Switzerland). Composite resin was applied in layers of a maximum of 2-mm thickness (Tetric Evo Ceram, Ivoclar Vivadent), and each layer was polymerized (Bluephase, Ivoclar Vivadent, 1200 mW/cm^2, 40 seconds). One experienced dentist carried out interproximal excess removal for a limited time period of two minutes before teeth were removed from the model and further analyzed.

QUAL Analysis

Teeth were cut through the center in the buccolingual direction, resulting in two halves containing one restoration each. Specimens were dehydrated through ascending grades of ethanol, fixed to an SEM holder, air-dried in a desiccator at approximately 20 hPa, and sputter coated with a 30-nm layer of gold (S150, Edwards, Marburg, Germany). For evaluation of the proximal restoration margins, specimens were magnified (30×) in an SEM (1810D, Amray, Bedford, MA, USA). One blinded examiner visually evaluated the marginal qualities by assigning one grade to each specimen. Grading of qualities was 1) perfect: continuous margin between

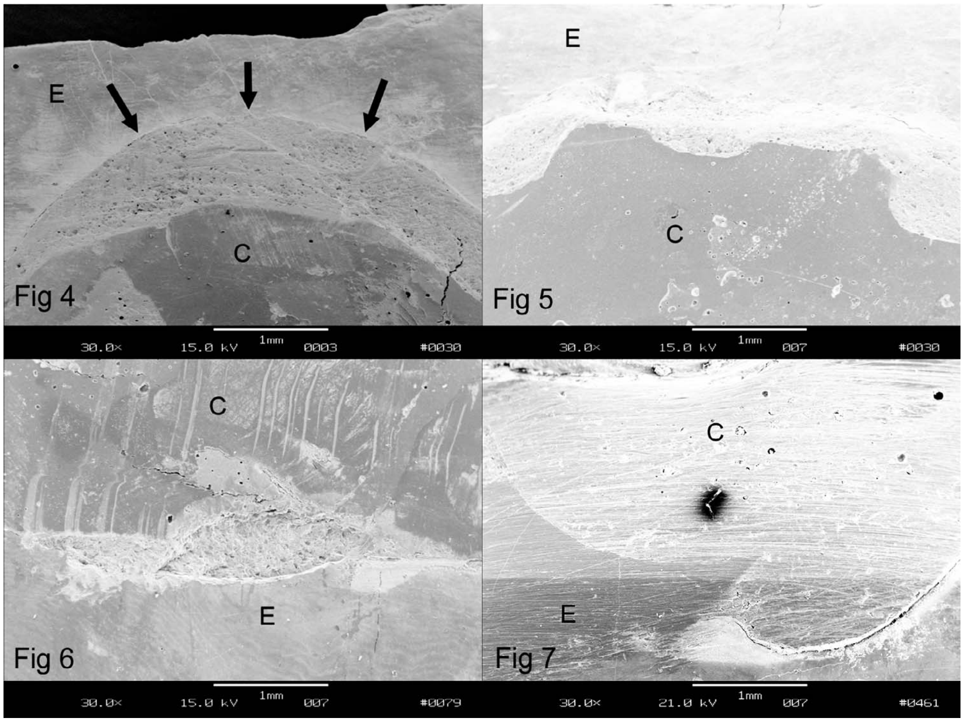

Figure 4. *SEM picture of margin quality (QUAL) graded as "perfect" after finishing with a microscalpel (E, enamel; C, composite resin; arrows, restoration margin).*
Figure 5. *SEM picture of margin quality (QUAN) graded as "excess" after finishing with scalpel number 21 (E, enamel; C, composite resin).*
Figure 6. *SEM picture of margin quality (QUAN) graded as "deficit" after finishing with a scaler (E, enamel; C, composite resin).*
Figure 7. *SEM picture of margin quality (QUAN) graded as "combination" after finishing with a finishing strip (E, enamel; C, composite).*

restoration and enamel surface without deficit or excess (Figure 4), 2) excess: excess composite resin material in relation to enamel margin visible (Figure 5), 3) deficit: deficit in composite resin material in relation to enamel margin visible (Figure 6), and 4) combination: deficit and excess of composite resin material at different sites of the visible margin (Figure 7).

QUAN Analysis

The same specimens were then removed from the SEM holder and embedded in methyl methacrylate (Paladur, HeraeusKulzer, Hanau, Germany). Three mesio-distal tooth slices parallel to the tooth axis and perpendicular to the proximal restoration margin (thickness 1.0 mm) were obtained with a water-cooled microtome saw (1600, Leitz, Bensheim, Germany). Surfaces were ground with wet silicon-carbide abrasive paper of descending grit (to 4000 grit), fixed to the specimen holder, and sputter coated again with a 30-nm layer of gold (S150, Edwards). SEM analysis (1810D, Amray) was performed at 60× magnification. The distance between tangents to restoration and enamel surface was measured (Figure 8) (analySIS Program, Soft imaging System, Emsis, Münster, Germany). Three measurements on each of the 30 specimens were averaged, resulting in a total of 30 values per group.

Statistical Analysis

Data were documented in Excel (Microsoft Excel 2010) and analyzed using SPSS (IBM SPSS Statistics for Windows version 20). Metrical data were normally distributed. Explorative data analysis was performed by calculating means and standard deviations for each group. Groups were compared using Student *t*-test and analysis of variance together with *post hoc* tests (Scheffé, level of significance $p>0.05$). Nominal data (QUAL) are presented as relative frequencies per group. Quantitative marginal analysis (QUAN) yielded positive measured values ("excess") as well as negative measured values ("deficit"). Perfect marginal quality (Figure 9) would thus be represented by a measured value of zero. Any excess or deficit was rated inferior; therefore, positive and negative values were processed as absolute values in the sense of a functional amount.

RESULTS

LOAD and CUT Testing

LOAD varied between 22.22 (1.96) N (mean [standard deviation]) and 95.83 (4.96). CUT values were between 7.61 (1.49) and 36.18 (9.61). Comparison of LOAD and CUT revealed that LOAD was significantly higher than CUT (Table 2) at all angles. The difference between LOAD and CUT was highest at an angle of 15 degrees. LOAD steadily decreased from 15

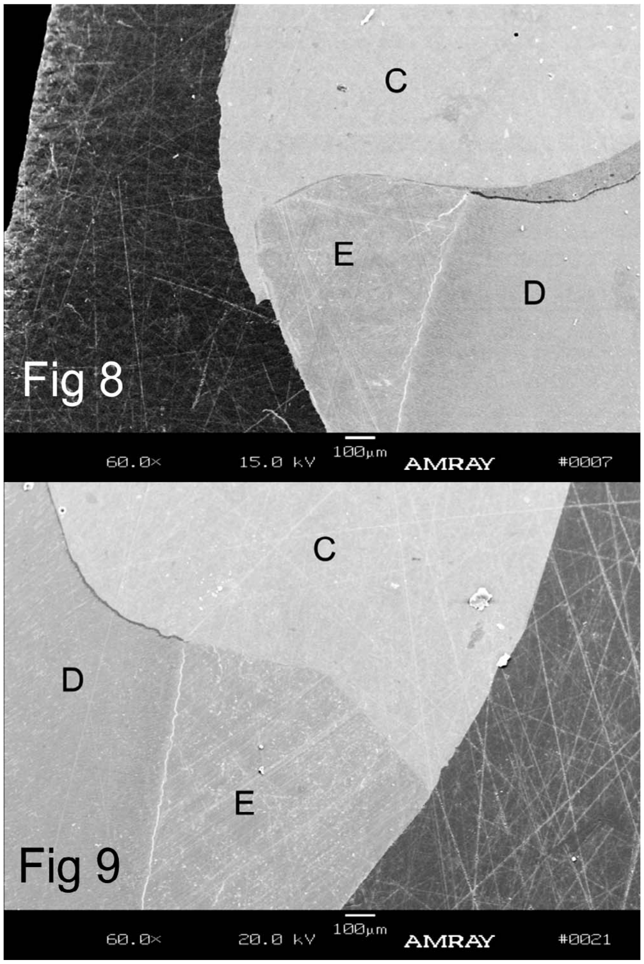

Figure 8. *SEM picture of residual overhang (QUAN) finished with scalpel number 21 (E, enamel; D, dentin; C, composite resin restoration).*
Figure 9. *SEM picture of perfect excess removal (QUAN) obtained with a microscalpel (E, enamel; D, dentin; C, composite resin restoration).*

degrees to more than 30 degrees and from 60 degrees to 75 degrees. CUT displayed a distinct outlying value at 60 degrees, where the forces for cutting were comparatively high. We assumed that this effect was seen due to the blade getting stuck in the resin and therefore not being able to cut freely any more.

QUAL Analysis

The greatest number of perfect margins was found with scalpel number 12 (relative frequency 36.7%), followed by the microscalpel and G5-ProShape (31.0% for both). Use of a scaler produced the lowest proportion of perfect margins (6.6%), and no perfect margins were seen with scalpel number 21 (0%). An excess of composite resin was most frequently seen with finishing strips (73.4%), whereas a scaler created the most deficits on margins (26.7%) (Figure 10).

QUAN Analysis

Absolute values for excess and deficit varied from 19.3 (4.4) μm (mean [standard deviation]) (microscalpel) to 116.0 (18.8) (finishing strips) (Table 3). Analysis of variance yielded significant differences between groups (*post hoc* Scheffé, $p=0.05$), showing that microscalpels, scalpel numbers 12 and 15, G5-ProShape, and G5-ProxoCare performed significantly better than finishing strips.

DISCUSSION

To our knowledge, this is the first study that presents data on a novel interproximal finishing device and that systematically compares eight different instruments in an experimental setup.

We evaluated the load strength of novel microscalpels in comparison to their cutting ability on standardized composite resin overhangs at different angles. The blades could be loaded to a significantly higher extent than that of the forces necessary for blade fracture. Our results revealed that the optimal working angle was 15 degrees.

To obtain access into the interproximal area, the idea was to scale down the size of scalpel blades,

Table 2. *Microscalpel Data for LOAD and CUT Testing at Different Angles, Mean (Standard Deviations in Parentheses), Minimum and Maximum Values, and p-Values (Two-Tailed Significance) from t-Tests (Paired)*

Angle (n=30, each)	LOAD (N)		CUT (N)		*p*-value
	Mean (SD)	Min/Max	Mean (SD)	Min/Max	*t*-Test, Two-Tailed Significance
15 degrees	95.83 (4.96)	87.00/104.00	7.61 (1.49)	5.66/12.60	<0.001
30 degrees	76.97 (9.59)	50.90/94.30	8.92 (2.82)	4.40/15.90	<0.001
60 degrees	57.86 (7.30)	34.60/69.80	36.18 (9.61)	18.50/48.90	<0.001
75 degrees	22.22 (1.96)	18.70/28.00	11.17 (4.01)	5.40/18.90	<0.001

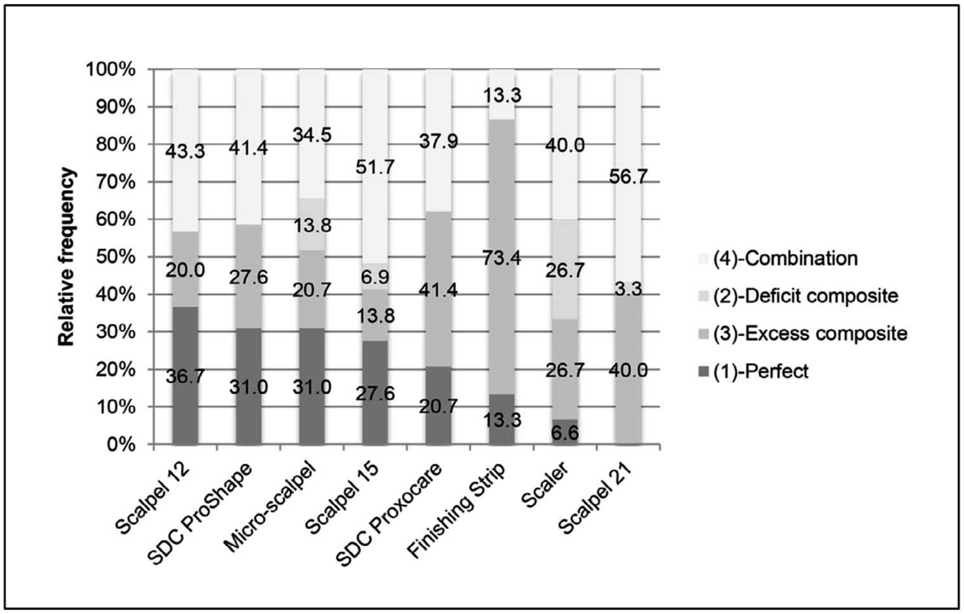

Figure 10. *Relative frequencies of margin qualities (QUAL) evaluated by SEM (n=30 per group).*

allowing for more maneuverability within the limited space. A more delicate blade, however, is prone to fracture more easily, especially when high forces are applied at unfavorable angles. However, in our tests the microscalpel proved to be robust enough to remove excess resin. It showed load-bearing values significantly higher than the forces necessary for fracture at all angles. Common dental scalpels are extremely robust and display high load strength. Pilot tests with scalpel blade numbers 12, 15, and 21 showed that their LOAD was beyond the testing range of our experimental setup, leading not to fractures of the blades but rather to destruction of the setup or to distortion of the holder (internal data). Therefore, a comparison of microscalpels with standard scalpels in terms of LOAD was not possible in our setup. Nevertheless, the data allow us to conclude that microscalpels are able to cut composite overhangs without the risk of overloading and/or fracture of the blades.

Table 3. *Absolute Values for Excess/Deficit (Mean and Standard Deviation [SD] in μm) Measured by SEM on Specimen Slices (n=30 Values per Group), Group Comparison With Analysis of Variance and* Post Hoc *Testing (Scheffé Procedure,* p*=0.05)*

Groups (n=30)	Mean (SD) (μm)	Min/Max (μm)
Microscalpel	19.3 (4.4)A[a]	0.0/84.3
Scalpel 12	32.1 (7.6)A	0.0/151.8
Scalpel 15	36.9 (11.6)A	0.0/299.4
G5-ProShape	37.5 (10.2)A	0.0/261.0
G5-Proxocare	53.6 (12.7)A	0.0/307.0
Scalpel 21	60.3 (9.8)AB	0.0/191.0
Scaler	60.5 (9.3)AB	0.0/201.7
Finishing strip	116.0 (18.8)B	0.0/412.3

[a] *Superscript letters designate subgroups with statistically significant differences.*

The rationale for the development of this microscalpel was the need for an optimized interproximal working device. Its shape should be such that both concave and convex surface anatomy can be worked on. Its size should be adequate to maneuver and work properly within the interdental space. In addition, a suitable instrument should work efficiently within a clinically acceptable amount of time. Concerning the time necessary for removal of excess material, Spinks and others[46] identified the fastest method as a motor-driven diamond tip. Three minutes were sufficient for complete excess removal. In comparison, in the same test, a sonic scaler needed seven minutes and a curette 15 minutes for the procedure. For this step of the restorative procedure, time periods longer than two to three minutes are clinically unsatisfactory since they entail undesirable delay for the treatment process. In this study, we chose two minutes as the time period to be investigated and tested different devices to assess how they would perform in removing excess within that time. Our results demonstrate that none of the tested instruments were able to create perfect margins in all specimens within the two-minute time period. The greatest proportion of perfect margins was produced by scalpel number 12 with a relative frequency of 36.7 percent. Scalpel number 21 was obviously too large to be able to reach into the

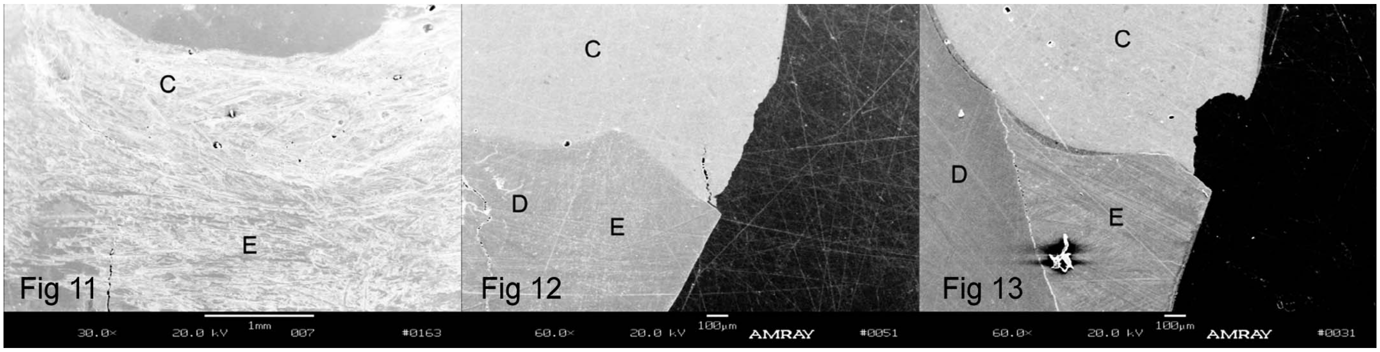

Figure 11. *SEM picture of distinct scratches and horizontal lines after use of G5-Proxocare (E: enamel; C, composite resin).*
Figure 12. *SEM picture of margin deficit and crack formation after scaler application (E, enamel; D, dentin; C, composite resin restoration).*
Figure 13. *SEM picture of large-scale marginal fracture after scaler application (E, enamel; D, dentin; C, composite resin restoration).*

interdental space and consequently failed to do the job. A strikingly high percentage of margins with excess were seen with finishing strips (73.4%, relative frequency). Even when coarse grit was used, they seem to be inadequate for the removal of distinct composite resin overhangs in the given time.

Since the goal of polishing and finishing should be to reconstruct the anatomically correct tooth shape, we graded both excess and deficit as "unfavorable" and transformed the negative and positive values into absolute values adding up to the final values of QUAN excess/deficit. The outcomes closest to the anatomically correct tooth shape, resulting in the lowest QUAN values, were displayed by microscalpels and scalpel numbers 12 and 15. The oscillating devices produced QUAN values in the midrange. Our study used them with coarse grit (60 μm), making efficient excess removal possible. Examination of the SEM pictures, however, shows distinct scratches and horizontal lines after their use (Figure 11). Similarly, Whitehead and others[47] saw enamel surface destruction after finishing with diamond finishing strips. They concluded that such roughness would be difficult to polish and promote the development of calculus, staining, and periodontal or cariological problems. Using scalpels is similar or more efficient, yet the blades seem to work in a much more material-selective manner than the oscillating devices, which strip enamel surfaces just as efficiently as restorative surfaces.

The efficient and material-selective cutting of composite resin makes scalpels preferable for excess removal in interdental spaces. However, another crucial aspect needs to be taken into consideration. Common scalpel holders are not angled like ergonomic scalers or curettes. This makes their use in the farthest posterior interdental spaces impossible. Depending on the mouth opening of the patient and the anatomical circumstances of teeth and tooth positions, the mesial aspect of the first molar is the farthest surface that can be reached. For interdental spaces posterior to those, the development of angled scalpel holders is necessary. For the moment, it seems likely that an ergonomically superior scaler would be used for this task. We saw, however, that their use resulted in high levels of composite resin deficits. Visual inspection of SEM images showed that frequent crack formation (Figure 12) and rough disruptions (Figure 13) in the marginal area were seen only in this group. Sharp scalers seem not to cut composite resin but rather to tear out pieces of composite, leaving rather disrupted surfaces. Clinical experience supports this idea. The scaler hooks onto the excess material, and considerable force is necessary to remove it. Large fragments are torn from the restoration, leaving rough breakout areas, and even further polishing might not be capable of smoothing these defects. Marginal breakdown, leakage, or secondary caries are possible long-term risks as a result. In this article, for the first time, the effects of the use of scalers to remove composite resin overhangs is demonstrated with examples of marginal breakouts and crack formation revealed by SEM.

As already mentioned in the introduction, research on this topic is rare, and comparable studies are not available. There are only a few publications that hint at the superiority of scalpel application in restorative dentistry. First, Pratten and others[48] analyzed surface qualities in anterior and posterior composite resin restorations and recommended the use of scalpel number 15 for proximal finishing since it yielded surface characteristics similar to those of carbide burs. They described that the scalpel blade can cleave the resin in a manner similar to the cutting of a rotating carbide bur. Second, Anami and others[36] reported that after adhesive cementation of ceramic blocks, the surface roughness and biofilm adhesion were least with the brush technique and subsequent polishing and after scalpel number 12 application.

In our study, the adequate sample size and the reproducible setup allowed reliable data collection. In the clinical setting, tooth anatomy, limited interdental accessibility, and the possibility of adjacent structures blocking instrument access might complicate the procedure, resulting in possible variations in values. Yet within the limitations of the study, we can conclude the following:

1) Novel microscalpels can be used for cutting composite resin without the risk of blade fracture.
2) Small and/or curved scalpels were superior to the other devices tested with regard to removing excess composite material in the presented setup.

CONCLUSION

There is a clinical need for the development and testing of interproximal finishing instruments. Microscalpels and/or standard curved scalpels provide good accessibility into the interproximal area and allow for material-selective removal of excess material. Oscillating finishing devices are universally and efficiently applicable, yet coarse-grit instruments carry the risk of enamel removal, creating a rough surface texture. A scaler can cause distinct large-scale fractures or crack formation in the marginal area, while plastic flexible finishing strips are not sufficient as exclusive finishing instruments.

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Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of the Ethikkommission der Medizinischen Fakultät Heidelberg. The approval code for this study is S-034/2010.

Conflict of Interest and Sources of Funding Statement

The authors declare that they have no financial or other relationships that might lead to actual or potential conflict of interest. This study was self-funded by the authors and their institutions in its major parts. SDC Switzerland SA (Bioggio, Switzerland) provided G5-ProShape and G5-Proxocare, and Trinon Titanium GmbH (Karlsruhe, Germany) provided microscalpel blades for this investigation.

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