



## Review Article

## Beveled vs. Perpendicular Incisions and The Effects on Wound Healing: A Review

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## ABSTRACT

Proper surgical technique is crucial for optimizing wound healing and reducing scar tissue formation. There are numerous measures a surgeon can take to improve wound healing; however, the angle of the incision made at the surgical site has been suggested to potentially play a role in wound healing, particularly between beveled and perpendicular incisions.

**Objectives:** The goal of this study was to analyze the literature and observe whether a discrepancy exists between using beveled vs perpendicular incisions in surgical procedures, as well as to understand the relationship between incision angles and physiologic wound healing.

**Methods:** Google Scholar, Pubmed, and MEDLINE searches regarding incision techniques were made to find relevant articles in the fields of plastic surgery, dermatologic surgery, periodontal surgery, and ophthalmic surgery which included studies from 2004 to 2023. The exclusion criteria consisted of studies that did not have a comparative design and/or were not revolved around incision angle.

**Results:** After filtering out irrelevant studies, we selected six studies that addressed the dichotomy between beveled and perpendicular incisions. Out of the six studies, four were in favor of beveled incisions, and the remaining studies either found no significant difference or reported benefits to some degree of using perpendicular cuts.

**Discussion:** The literature seems to suggest that beveled incisions have an advantage over perpendicular incisions in wound healing, particularly in the aspects of esthetic and accelerated wound healing. This is potentially due to the increased surface area of the dermis, preservation of hair follicles, and decreased incidence of infection.

**Conclusion:** Although the literature seems to favor beveled incisions, a definitive conclusion cannot be made as there is not sufficient evidence to support the superiority of one incision type over the other.

## 1. Introduction

Proper wound healing is a high priority in most surgeries, particularly when operating on tissues with a high esthetic demand. Healing of a wound can yield a less visible scar, which can be modified through many aspects including flap design, post-operative pharmaceuticals, minimizing infection, etc. However, in this literature review, we took a particular interest in comparing different incision techniques on soft tissue and analyzing the effects on wound healing, specifically beveled vs. perpendicular incisions. Our objectives for this study were two-fold: 1) to elucidate trends regarding the optimal incision angle and 2) to understand and relate incision angles to the physiology of wound healing. Answering these objectives can provide significant value for both surgeons and patients, as knowing the optimal incision angle can

perhaps yield faster wound healing, enhanced esthetics, consistency, and lower incidence of infection. To the best of our knowledge, this is the first literature review to attempt to combine multiple studies in the goal of elucidating any dichotomy between beveled and perpendicular incisions, particularly on wound healing and scar tissue formation.

## 2. Methods

Google Scholar, Pubmed, and MEDLINE searches were conducted to find articles that compared incision angles in various fields of surgery. Search engine keywords included *beveled*, *perpendicular*, *vertical*, *incisions*, and *wound healing* from the years 2004 to 2023. The search yielded 4282 results and studies were filtered out according to the 2020 PRISMA guidelines. One study [12] was found through reference of

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another similar study [13] and was included as part of this review, even though it was not part of the initial screening process. Our inclusion criteria included studies that directly compared the effects of beveled vs. perpendicular incisions, and we excluded studies that did not exactly fit that criteria. These excluded studies consisted of articles that did not have a comparative design (only discussed one type of incision) and articles that were not revolved around incision angle. The authors each reviewed the articles independently and analyzed the studies accordingly. The studies were analyzed to extract data regarding explanations to the optimal incision type and differences in wound healing between both.

### 3. Results

After filtering out studies that were not relevant to this review, we were able to yield a total of six studies divided into four fields of surgery: Plastic, dermatologic, periodontal, and ophthalmic surgery. Four out of six studies were in favor of using beveled incisions as a functional way of maximizing wound healing, and none of the studies were completely in favor of perpendicular. The other two studies in this review either found no difference in the two incision types or elaborated on the benefits of both type of incisions (Table 1).

#### 3.1. Plastic surgery

The study we found in the field of plastic surgery was done by Feindendegen et al. (2018) [1]. This study performed a flat incision technique (FIT), which utilizes a 20-degree beveled incision, on the skin surface of a melanoma patient. The justification for using this incision was because 20-degree beveled incisions have been shown to enhance dermal layers of the wound [2,3] as well as promote hair growth through the scar [4], and the authors wanted to confirm its viability and predictability as a surgical technique. The technique of Feindendegen's incision involved making a superior incision on the supraorbital skin, and an inferior incision directly superior to the eyebrow in order to include hair and assess the growth of hair through the scar. One year after surgery, the scar tissue was barely visible and showed symmetrical regrowth of hair through the eyebrow. Feindendegen et al. (2019) [5] did a similar study in which they compared this same 20-degree beveled incision to perpendicular incisions in five different patients. The authors performed tumor excisions and facelifts with both beveled and

**Table 1**  
Summary of studies comparing beveled vs. perpendicular incisions in the fields of plastic, dermatologic, periodontal, and ophthalmic surgery. Each row is divided into surgical discipline, the favored incision type as a result of the study, the evidence to support its use, and respective references.

Field	Favored incision type	Evidence	Reference
Plastic surgery	Beveled	Beveled incision doubles the area of dermal layer	[1]
	Beveled	Beveled 20-degree incision displays less scar formation and lower inflammation	[5]
Dermatology	Beveled	Allows complete removal of tumor, tissue easy to flatten	[6]
	Perpendicular	Improved esthetics of secondary intention wound-healing, lower chance of tumor transection	[6]
Periodontal Surgery	Beveled	Wider tissue interface, faster reorganization	[12]
	Beveled	Accelerated wound healing	[13]
	Perpendicular	Similar wound healing 28 days post-surgery	[13]
Ophthalmic surgery	Beveled (smaller angle)	Tighter seal of incision edges at high IOP	[14]
	Beveled (larger angle)	Tighter seal of incision edges at low IOP	[14]

perpendicular incisions. Gross and histologic examination six months post-operatively revealed a more cosmetic outcome in the beveled technique as well as less dermal scarring and inflammation and a higher number of hair follicles in beveled incisions [5]. In summary, Feindendegen et al. (2019) [5] found that beveled incisions are beneficial for yielding an esthetic outcome post-operatively, as beveled incisions allowed for better regrowth of hair and less dermal scarring.

#### 3.2. Dermatologic surgery

Yu et al. (2019) [6] reviewed cases of Mohs surgery from July 2014 to December 2016 performed by two different surgeons. Mohs surgery is the surgical procedure used to excise various skin neoplasms such as basal cell and squamous cell carcinoma [7]. The incision in this procedure is typically done with a beveled incision [8] and benefits of using both a beveled and perpendicular incision have been mentioned. Advantages of beveling the incision include faster wound healing and flatter tissue processing whereas benefits of perpendicular incisions include reliability, less risk of tumor transection, and easier histopathologic examination [8,9,10,11]. Based on of this background information, Yu et al. (2019) [6] analyzed 536 slides from 2825 cases of Mohs surgery using a beveled vs. perpendicular incision for the purpose of elucidating any difference between the histopathologic healing of the two incision types. The slides were prepared and analyzed and given a score from 1 to 5, with 5 being a perfect histopathologic score. The authors found that across all of these specimens, the mean score was the same for both beveled and perpendicular incisions. Therefore, using either a beveled- or non-beveled-approach to performing Moh's surgery is a viable option, and the decision is likely dependent on the preference of the surgeon [6].

#### 3.3. Periodontal surgery

We analyzed two studies in the literature that compared beveled vs. perpendicular incisions in periodontal tissues. The first study was done in 1984, where two incision types were performed in monkeys and analyzed their clinical outcomes [12]. The authors observed improved wound healing for beveled incisions in contrast to perpendicular incisions, and their justification was based on a wider tissue interface and faster reorganization in the beveled incision [12]. Nearly forty years later, Sabeti et al. (2021) [13] compared the two incision types on periodontal tissues. The aim of their study was to evaluate the histological and clinical features that differ between beveled and perpendicular vertical releasing incisions in mongrel dogs. The dogs were randomly subjected to perpendicular or beveled vertical releasing incisions in each quadrant of each dog. The animals were evaluated daily during the first week, and were then observed in time intervals (9, 14, 21, and 28 days after surgery). At 9 days after surgery, visible grooves were observed in marginal tissues, and greater inflammatory infiltration was observed in the beveled incisions. This contrasted Kon et al., as they found greater inflammation in perpendicular incisions at day 9. However, the differences were not found to be statistically significant. At 14 days after surgery, depressions were still present in perpendicular incision sites but not at beveled incision types, which also confirms the findings of Kon et al., who noticed visible grooves at the perpendicular incision sites. On day 14, Sabeti et al. also found shorter and more irregular capillary loops in perpendicular incisions, but wounds created with beveled incisions displayed better healing with more organized collagen fibers. Interestingly, the epithelium was healed 21–28 days after surgery in both perpendicular and beveled incisions, whereas Kon et al. found better healing in beveled incisions. Therefore, the authors concluded that clinical and histological features 28 days after surgery between perpendicular and beveled vertical releasing incisions are similar, and not enough evidence supports the benefit of one over the other regarding wound healing.

### 3.4. Ophthalmic surgery

Taban et al. (2004) [14] evaluated the effects of intraocular pressure, location, and angle of cataract incisions on post-operative sealing and wound gaping ex vivo. The purpose of this was to provide a justification and reasoning to limit the incidence of endophthalmitis, a common postoperative complication characterized by infection and inflammation of the intraocular fluids. Intuitively, the higher the wound gaping, the higher the chance of developing endophthalmitis due to the edges of the wound remaining opening and allowing the entrance of various microorganisms. The study was designed by taking 20 rabbit eyes and 14 human globes and performing different angled incisions on each under various intraocular pressures. Specifically, the study compared only beveled incisions of differing angles (i.e., 20–60-degree incisions). Intraocular pressure was included as a variable since transient increases and decreases in IOP can dictate the efficacy of the incision angle. In summary the article yielded two important findings: 1) smaller incision angles (closer to 0°) had less wound gaping at high IOP, and larger angles had less wound gaping at low IOP and 2) the critical angle for ideal wound gaping and subsequent lower incidence of endophthalmitis was 36–49° for ocular incisions [14]. Therefore, this study concluded that there are many variables that play a role in the morphology of cataract incisions, including the angle and location of the incision as well as the intraocular pressure.

## 4. Discussion

Although we only had six studies that we used to address the potential dichotomy of beveled vs. perpendicular incisions, there are some consistent trends among these articles. Beveled incisions seem to be beneficial in the aspect of improving esthetics, accelerating the wound healing process, and minimizing infections. Each of these aspects consist of evidence to support their use cases.

### 4.1. Esthetics

In the aspect of improving esthetics, this happens because of two reasons: 1) beveling the incision maximizes hair growth through scar tissue, and 2) beveling increases the wound healing potential [1,5]. If a surgeon made a perpendicular incision relative to the skin, this would lacerate the entirety of the hair shaft by cutting through the more basal layers of the skin. By beveling an incision to the skin, this preserves the most superficial portions of the hair follicle and preserves the hair bulb, therefore increasing the regeneration capacity of the hair follicle [1]. A beveled incision also decreases the distance to which the distal edges of the hair follicle have to grow to reach the surface of the epidermis, hence leading to more efficient regrowth of hair through scar tissue [1]. Regarding the overall increase in wound healing potential that has been described from using a beveled incision, this occurs due to an increase in the surface area of the dermis [1]. By beveling the incision relative to the skin surface, the surface layer of the dermis is increased compared to if the incision was 90. This is ideal because the dermis contains numerous amounts of fibroblasts, hair follicles, and neurovascular bundles that are

necessary for wound healing, so by increasing the dermal surface area the wound healing capabilities are consequently increased (Fig. 1).

### 4.2. Acceleration of healing

The second aspect in which beveled incisions seem to show superiority is in its ability to accelerate the wound healing process. A few of the studies we analyzed have demonstrated that the tissue susceptible to a beveled incision seem to display better wound healing at an earlier time frame. The study in periodontal surgery done by Sabeti et al. (2021) [13] observed shorter and irregular capillary loops at day 14 in perpendicular incisions, whereas the beveled incisions displayed abundant uniform collagen bundles and a completely healed epithelium on the same day. Although this study did not note a difference in the two incisions 28 days post-operatively, the finding that beveled incisions had a superior histological appearance provides evidence that beveled incisions may potentiate more accelerated wound healing.

### 4.3. Minimizing infection

The last point in favor of using beveled incisions is the potential to minimize infection. The study done by Taban et al. (2004) [14] gave evidence that beveled incisions can lead to a decrease in wound edge gaping, allowing for the edges of the wound to approximate and heal. By having a sealed wound, the likelihood of microorganisms entering the wound and causing localized or systemic infection is greatly diminished. Although the design of this study had multiple variables (fluctuation intraocular pressures, eyes from different animals, etc.) and was not a straightforward comparison of the two incision types, what we took from this study is that the critical angle for wound edge approximation for human globes was 36–49°, which supports the use of beveled incisions in minimizing infection [14].

### 4.4. Are beveled incisions superior?

Although it may seem like beveled incisions are superior to vertical incisions, this does not always seem to be the case. The study we looked into in dermatologic surgery was a very wide scaled study and they analyzed hundreds of microscopic tissue specimens between beveled and perpendicular incisions. They did not find any significant difference between the two groups and concluded that optimal wound healing can be achieved in both incision types. This was similar to the findings of Sabeti et al. (2021) who also found very similar outcomes between beveled and perpendicular incisions after nearly a month post-operatively. Instead, the authors proposed that the use of the incision type will likely be determined by preference or the nature of the surgery. The authors mentioned a few reasons for using a beveled incision, including faster wound healing by secondary intention (due to a shallower surgical defect) and flatter tissue processing [6]. Benefits of using a perpendicular revolve around its reliability, consistency, and low risk [6]. If a cancerous mass needs to be excised, Yu et al. (2019) suggests the use of a perpendicular incision, as there will be a lower likelihood that the mass will be laceration since a perpendicular incision will follow the

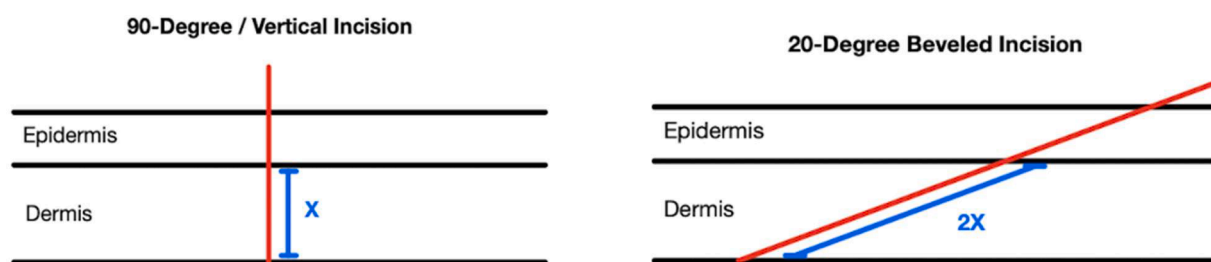


Fig. 1. A 90-degree perpendicular (vertical) incision compared to a 20-degree beveled incision and the difference in the amount of dermal surface area each incision covers. Notice how the beveled incision can nearly double the surface of the dermis due to the design of the incision.

circumferential margins of the tumor. It can be imagined that if the tumor is excised with a beveled incision, the nature of the incision itself can perhaps create a tendency to lacerate into the tumor and compromise the histologic quality as well as potentiate hemorrhage if the tumor is heavily vascularized. Perpendicular incisions also allow for better imaging of adnexal structures within a histologic specimen [6]. Intuitively, a perpendicular incision will allow these structures to be clearly visible and symmetrical on cross-section, whereas beveled incisions can perhaps create more of an irregular appearance of the structures. Lastly, perpendicular incisions are the typical “traditional” incision and are considered easier and more reliable to perform [6].

## 5. Conclusion

In the present study, we aimed to elucidate trends regarding the optimal incision angle and understand the underlying physiology of incision design and angulation related to wound healing. We provided explanations to how changing the incision angle can perhaps yield more esthetic scar tissue formation as well as justifications to using a certain incision type over the other. Although this review was limited to only 6 studies, there are some common trends among the studies that beveled incisions lead to faster and more esthetic wound healing, and perpendicular incisions can perhaps yield similar results and are beneficial in certain cases.

With the current evidence, it can be inferred that the decision of which incision type to use is entirely dependent on the nature of the surgery itself and the preference of the surgeon, as there is not enough supporting evidence in the literature to determine the optimal incision angle. The lack of large-scale studies and well controlled experiments with direct comparisons between incision types hinders our ability to determine the superior incision angle, and more in-depth studies are needed regarding these principles across various fields of surgery.

## CRedit authorship contribution statement

**Joseph De Leon:** Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Mojtaba Wali:** Investigation. **Georgios E. Romanos:** Project administration, Supervision, Validation, Writing – review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.sipas.2023.100226](https://doi.org/10.1016/j.sipas.2023.100226).

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