

## A Comparison of Procedures for the Removal of Epidermoid Cysts

In this paper, I describe in detail the causes and nature of epidermoid inclusion cysts, and describe why a cyst may be removed. I then compare the two most common surgical removal methods of these cysts.

Epidermoid cysts, also called epidermal inclusion cysts, are benign, sub-epidermal skin tumors which are filled with a keratinous pus (Aaron, 2016). These cysts are usually harmless, and the decision to remove them is often made with cosmetics in mind. If a cyst becomes inflamed, infected, or painful, they are removed to relieve a patient of pain and discomfort (Aaron, 2016). There is more than one surgical procedure designed to remove epidermal cysts, and choosing a procedure depends on the situation. If a cyst is on the face and a small scar is desirable, then a surgeon may choose to use minimal incision, while a larger cyst may require a full excision (Nakamura, 2001). Although either of the two methods of surgical removal of epidermoid cysts may be appropriate in different situations, minimal incision, expression, and later excision of the cyst wall should be the default for dermatologists due to its wider applicability and smaller healing scar.

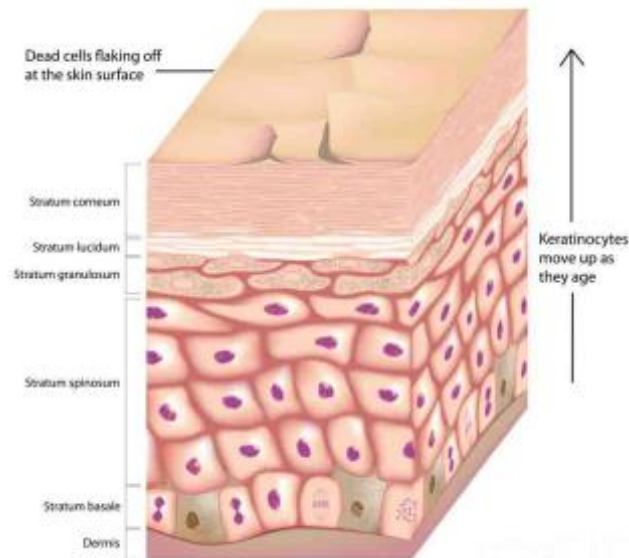
Epidermoid cysts affect the largest organ in the human body; the skin. According to Parker (2013), the skin isn't as simple as a waterproof covering; it is a multi-layered and multifunction organ.

The deepest layer is the subcutaneous layer, which insulates the body. The center layer is called the dermis, and it contains the skin's main functional bodies, including the hair follicles, sebaceous glands, sweat glands, touch receptors, and temperature receptors (Parker, 2013).

The hair bulb, hair follicle, matrix, erector pili muscle, and sebaceous gland are all part of the pilosebaceous unit (Parker, 2013). This unit is what produces the fine hairs that cover the entire body. The hair grows from the hair bulb into the hair follicle, which is a pouch of cuboidal epithelial tissue, and protrudes out onto the surface of the skin (Parker, 2013). The follicle contains the sebaceous gland, which produces an oily substance called sebum (Parker, 2013). Sebum is secreted onto each hair, which spreads easily across the surface of the epidermis, and lubricates and waterproofs the skin (Parker, 2013). The infundibulum of the pilosebaceous unit refers to the topmost area of the hair follicle, nearly where the hair protrudes from the epidermis (*The Four*, n.d.). The infundibulum is often the source of the epidermal cyst.

The outermost layer of the skin, called the epidermis, is composed of a basal production layer of skin cells, and gradually more dead and flattened skin cells nearer the surface of the skin (Parker, 2013). Skin cells are called keratinocytes; they are cells which are 'born' cuboidal, then begin to produce keratin, eventually replacing their own cytoplasm, organelles, and nucleus with tough keratin. The basal layer of the epidermis is composed of simple cuboidal epithelial cells,

which continuously divide to produce the firm outer layer of the skin (Parker, 2013). As cells are produced, they begin to move up toward the surface, and as they get closer to the top, they become flatter and more scale-like while producing and filling up with keratin (Parker, 2013). If examining a cross-section of the epidermis, four general layers can be identified (see Figure 1).



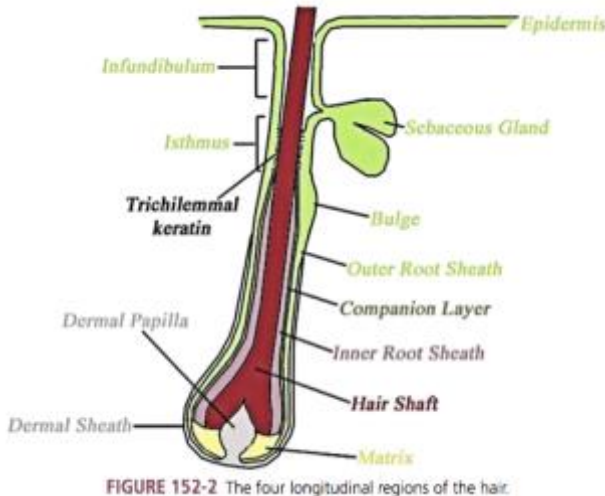
**Figure 1:** ("Cross-section of the Epidermis," 2015).

The basal layer (Stratum Basale) is made up of basal epidermal cells, which reproduce and push up more skin cells (Lawton, 2006). The next layer is called the prickly-cell layer (Stratum Spinosum) (Lawton, 2006). The layer after is called the granular layer (Stratum Granulosum), which is composed of advanced keratinocyte cells that contain keratohyalin granules (Lawton, 2006). Keratin keratohyalin helps to form microtubules in skin cells, which give them a firm, skeletal structure (Lawton, 2006). Keratinocytes in the granular stage of development also begin to digest their own nuclei and cytoplasm, filling up with precursors to structural keratin and other support proteins (Lawton, 2006).

Keratinocyte cells in this stage produce and secrete lamellar granules, which contribute to the next layer (Ishida-Yamamoto, 2004). This next layer is the clear layer, called the Stratum Lucidum, is composed of advanced keratinocytes and many lamellar granules that secrete lipids and enzymes (Ishida-Yamamoto, 2004). The lipids they excrete make the clear layer waterproof, while the enzymes are key to shedding the surface cells later in the keratinocytes' life cycle (Ishida-Yamamoto, 2004). These lamellar granules are part of what causes an epidermoid cyst to contain lipids; these granules produce lipids and excrete them into the cyst. The final surface layer, called the Stratum Corneum, is composed of fully dead, flattened, keratin-filled keratinocytes which eventually fall away (Ishida-Yamamoto, 2004). As epidermal cells 'slough off' the surface of the skin, through enzymatic activity or due to abrasion, they are replenished by more cells coming from underneath (Parker, 2013). In this way, the surface of the skin is constantly renewed (Parker, 2013).

There are a number of possible causes for epidermoid cysts, some hereditary and some accidental. One accidental cause is physical damage to the skin, creating what's called an implantation cyst (Oakley, 2016). If the skin is penetrated, cut, or otherwise injured, whether during a separate surgery or by accident, there is a small risk that an epidermoid cyst will form (Oakley, 2016). When the skin is disturbed in this way, the dead cells and the live cuboidal basal cells of the epidermis may be forced into the dermis without being destroyed (Oakley, 2016). Once these cells are inside the dermis, they continue to reproduce and form keratinized dead cells, but since they are inside the dermis, these cells cannot 'slough off' (Oakley, 2016). The keratinized cells are trapped, and the basal cells continue to produce more, resulting in a growing

cyst whose wall is the basal epidermal cells and whose interior is filled with keratin and lipids (Oakley, 2016). Another mechanism of the accidental formation of a cyst is the sealing of the infundibulum (see Figure 2) of the hair follicle shaft (Ingram & Oldfield, 1937). The same sort of physical trauma that causes implantation cysts can force the hair follicle shaft to be squeezed and



**Figure 2: Hair Follicle** (“The Four”, 2014).

sealed shut (Ingram & Oldfield, 1937). This results in a cyst because the hair follicle is made of the basal cells of the epidermis; the follicle is essentially an epidermis pocket, so when it’s sealed, the basal cells multiply and fill the now-cyst with keratin (Ingram & Oldfield, 1937). If the sebaceous gland remains intact, it will also continue to secrete oily sebum into the cyst, which is called a retention cyst (Ingram & Oldfield, 1937). A similar mechanism is outlined by Zuber (2002) in which the pilosebaceous unit ruptures similar to acne, and leads to a cyst. Epidermoid cysts can also form as a symptom of hereditary disorders such as the autosomal dominant Gardner’s syndrome (Wehbi, 2016), or as a result of random

mutations in the enzymes associated with flaking of keratinocytes or mutations in the production of keratin or its intermediates (Ingram & Oldfield, 1937). An established epidermoid cyst has a distinct cyst wall and an interior substance. An epidermoid cyst can range in size between 5 mm to 5 cm in diameter (Ingram & Oldfield, 1937).



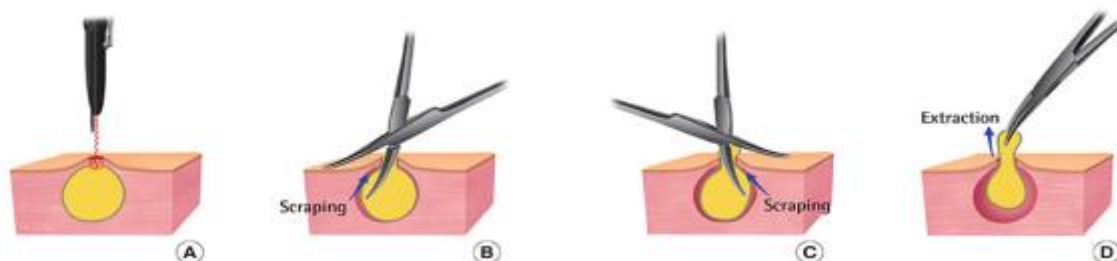
**Figure 3: a mild sebaceous cyst.** This one is not swollen or infected. The center dot is the punctum, and the dotted circle outlines the edges of the cyst. (“Epidermal Cyst,” 2015)

It is usually globular, and can be moved around underneath the skin (Zuber, 2002). The surface of the skin directly above the cyst usually has a small black pore called the punctum (Zuber, 2002). Depending on the specific cause of the epidermoid cyst, whether implantation or retention, it will be in a slightly different position relative to the epidermis. In either case, the wall of the cyst is the same; it’s composed of the same stratified squamous epithelial tissue as the epidermis (Kasper & Fauci, 2015). Analyses of cyst walls have found that they contain a very well-defined granular layer (Stratum Granulosum), meaning that most of the epithelial cells are almost completely filled with keratin (Fromm, 2016). The thick granular layer also means that a cyst will contain lots of lamellar granules, which contribute to the fat content of the cyst, as lamellar granules produce the oil that waterproofs the Stratum Lucidum (Lawton, 2006). The interior of the cyst is a white-yellow pus substance composed of keratin, sebum, and occasionally fat cells or some hairs. It is described be spongy or pasty depending on the individual. Depending on the location of the cyst on the body, it will contain a different proportion of sebaceous glands and lamellar granules, so cysts in varying locations will have slightly varying compositions, even if all of them are epidermoid cysts (Kasper & Fauci, 2015; Aaron 2016). The interior filling is where

epidermoid cysts vary most obviously from true sebaceous cysts; true sebaceous cysts come from the sebaceous gland, so they are filled with an oily liquid instead of a keratinous paste (“Epidermoid Cysts”, 2014).

As epidermoid cysts are usually benign and asymptomatic, there are a set of specific reasons why a medical professional may suggest surgical removal. The purpose for treatment impacts later decisions about which surgery to use. A doctor may recommend removal if any swelling, redness, or pain occur (Conrad-Stoppler, 2016). Such symptoms absolutely necessitate the removal of the cyst to avoid other adverse effects; a chronically inflamed cyst can develop into cancer or an ulcer-like lesion on the skin (Jun et al., 2010). These symptoms may arise for one of two reasons. If the patient, in an attempt at a home-remedy, applies pressure to the cyst in order to express its contents, they may cause the cyst wall to burst (Conrad-Stoppler, 2016). This causes the interior contents of the cyst to leak out into the surrounding dermis and epidermis, resulting in inflammation, and higher potential for infection (Conrad-Stoppler, 2016). The second reason for such symptoms is bacterial infection. Although rare, bacteria may be introduced into the cyst through a cut or puncture to the cyst (Conrad-Stoppler, 2016). The interior of epidermoid cysts is an ideal environment for bacteria to thrive; it’s filled with energy-packed lipids and proteins, and bacterial infection will cause a similar immune system response which will cause swelling and inflammation (Conrad-Stoppler, 2016). In addition, once a bacterial infection has occurred once, even if the immune system quells it, the cyst is more vulnerable to further infections, so removal is necessary (Calne, 2006). If a cyst isn’t inflamed or infected, a doctor may still recommend removal. If the cyst is large in a location where it disturbs the function of other organs, it may cause pain or other symptoms (Conrad-Stoppler, 2016). For example, if a cyst is in the genital area, it may pinch one of the many delicate tubules, including the urethra, resulting in painful urination or a general pinching discomfort (Conrad-Stoppler, 2016). Both of these increase the risk of local infections, so the cyst must be removed (Calne, 2006). Similarly, if a cyst on the face interferes with the eyes, nose, or mouth, it could obstruct breathing and eating, or impede the senses of sight and smell, which would also warrant the removal of a benign cyst (Conrad-Stoppler, 2016). The cyst may also interfere with daily life without impeding other organs; a cyst on the head may make combing the hair more difficult, while a neck cyst will be aggravated by a shirt collar (Sempowski, 2006). Finally, if the cyst is very large, in a prominent location, or otherwise unsightly, it is to the psychological detriment of the patient, and will require removal with an eye toward aesthetics (Nakamura, 2001).

Any surgery involves complications. The most frustrating complication of any cyst removal surgery is recurrence of the cyst. Recurrence may happen for one of two known reason. The first isn’t a true recurrence but an additional cyst; since removal surgeries involve cutting the skin, the epidermis may become implanted in the dermis again, causing a new implantation cyst to form (Oakley, 2016). The second and more likely recurrence is caused by a piece of the cyst



**Figure 4: Removal through minimal incision using a laser (“Epidermal Cyst”, 2015)**

wall remaining in the cavity (Zuber, 2002). The cyst wall is very friable and fragile, so it's very likely to break during any surgery (Zuber, 2002). If it breaks and some of it remains (alive) inside the cyst, it will continue to produce keratinized cells and fill the cavity left by the cyst with more keratin, leading to a new pseudo-cyst and probably a severe infection (Zuber, 2002; Calne, 2006). For this reason, one of the greatest goals of removal procedures is to avoid breaking the cyst wall and leaving it inside.

One surgical procedure a doctor may recommend is minimal incision, drainage of the cyst, and the later excision of the cyst wall (see Figure 4). There are three widely recognized variants of this procedure, but all three have the same principle. The essential procedure is to make a small opening in the top of the cyst, generally in the center, or the punctum (Nakamura, 2001). Then, through manipulation and pressure, the paste-like interior of the cyst is pushed out through the opening (Nakamura, 2001). The cyst wall is shifted around a little in its cavity in order to loosen it, but then it is left fully intact and inside, and the interior is packed with gauze to prevent the cyst wall from re-filling completely (Nakamura, 2001). After the keratinous pus is squeezed out, the cyst is usually much smaller and less intrusive, and in some cases it won't re-fill to any significant extent (Nakamura, 2001). For this reason, some patients may elect to simply allow the incision to heal over the cyst wall and leave the now-reduced cyst alone (Nakamura, 2001). However, because the risk of recurrence of the cyst or infection, the patient will usually return in 1-2 months, at which point the incision is re-opened and the cyst wall is removed. During these two months, if pressure was applied to the cyst very carefully, the cyst wall gradually loosens from the interior of the skin, and crumples and shrinks to a small wrinkled capsule with a little fluid inside (Wu et al., 2009). This is called a prolapse. This is why minimal incision functions despite the tiny incision: since the cyst wall is not torn apart but is loosened, it will tighten and shrink, which allows it to be removed completely despite a small incision (Wu et al., 2009).

The three variations in the minimal incision surgery all stem from the method of creating the initial incision. The most basic method, outlined by Nakamura (2001) among others, involves making a small incision with a scalpel directly through the punctum of the cyst. The other



**Figure 5: dermal punch**  
("Photograph of a Dermal",  
2014)

common method of making the opening is through punch biopsy. A punch biopsy involves using a dermal punch to punch a cylindrical hole in the top of the cyst, usually on the punctum (Moore et al., 2007). A dermal punch is like a scalpel, but the blade is in the shape of a cylinder (see Figure 5). Punch biopsy is usually recommended if the cyst is very large, or if it is deeper than normal in the skin (Moore et al., 2007). It may also be used when the cyst occurs over a soft area such as the neck or cheek to make expression of the interior easier (Moore et al., 2007). The third, newest, and probably most effective variant of the minimal incision surgery is through the use of a laser punch, first described by Wu et al. (2009). This involves the use of a strong laser beam to super-heat and 'cut' through the top of the cyst by destroying

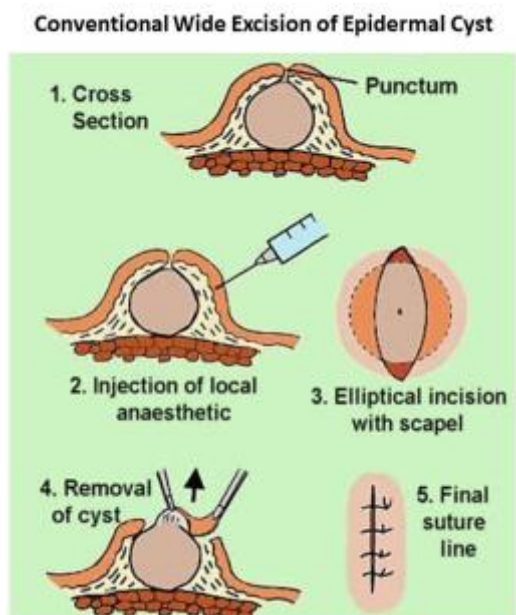
any cells in the path of the laser (Wu et al. 2009). The use of a laser punch is very effective because it pierces through to the inside of the cyst very quickly, and does not require excessive peripheral damage; the use of a scalpel produces corners and edges which may not heal well, and a dermal punch requires forceful twisting to make a hole (Wu et al. 2009). Since the laser punch involves minimal disturbance of the cyst, it's much less likely to cause the cyst wall to break



(Wu et al. 2009). It also reduces the risk of another inclusion cyst from the scalpel pushing epidermal cells into the dermis (Wu et al. 2009).

Minimal incision surgery has some positive and negative qualities. The most significant positive quality of this surgery is that the scar that remains is very, very small and barely noticeable (Moore et al., 2007). The initial surgery, incision and drainage, is very quick and simple, and since the second half of the surgery is elective, so the entire procedure can be treated as a cyst reduction rather than removal, if the cyst isn't infected or inflamed. The cons are numerous, but not as significant as the pros. The greatest negative quality of this surgery is that minimal incision has a much higher chance of recurrence of the cyst. While a careful draining will result in a small, easily removable cyst wall, the slightest breakdown of the wall can cause recurrence; once the second surgery occurs, a bit of epidermis may remain, causing a recurrence of the cyst (Jun et al., 2010; Zuber, 2002). This can be avoided: even if the cyst wall breaks, it's very possible to remove every remaining piece, but the combination of carelessness and the obstructed view of the interior of the cyst usually means that the surgeon will miss a piece if the wall is broken (Jun et al., 2010; Moore et al., 2007). Other cons include a longer average period of antibiotics and a longer period of morbidity, both due to the prolonged time between the two surgeries.

The other procedure a physician may choose is removal through wide elliptical excision. This procedure is fairly simple (see Figure 6). Under local anesthetic, the surgeon makes a long linear or a wide elliptical incision with a sharp scalpel (Jun et al., 2010; "Epidermal Cyst", 2015). Then, if using elliptical incision, the topmost skin layer is removed (Jun et al., 2010). Using forceps, the surgeon removes the entire cyst, with the cyst wall completely intact, as well as any skin or fat included in the initial cut (Jun et al., 2010). If the cyst wall breaks during excision, the elliptical incision is widened and the opening is carefully cleared of any cyst material, and the cut is closed with multiple sutures (Jun et al., 2010). There are a few pros and cons to this



**Figure 6:** Conventional Wide Excision ("Epidermal Cyst", 2015)

surgery. In a recent study, Jun et al. (2010) compared wide elliptical excision to minimal incision and found that wide excision required a shorter period on antibiotics, at an average of 5.1 days versus 10.9 days in a group of 351 patients. The same study found that this method produced a significantly shorter healing time at an average of 10.1 days versus 31.3 days (Jun et al., 2010). 'Healing' here is defined as the complete removal of the cyst and the beginning of normal healing and closure of any remaining wound (Jun et al., 2010). This study also found that, due to reduced quantity of antibiotics, surgery dates, and office visits, the overall cost of the procedure was lower for wide elliptical excision (Jun et al., 2010). Finally, since the procedure involves just one surgery and healing time is simplified, the overall morbidity period (the time a patient is ill or injured) is reduced (Jun et al., 2010). The cons of the procedure are relatively few, but they are significant. First, due to the large cut there is a higher recorded rate of postoperative wound infection, based on a 30-day follow-up period; 6% of

wide excision patients got an infection versus 3% of minimal incision patients (Jun et al., 2010). This may be a negligible error, but in any case, the enormous cut is objectively more invasive, and more invasive surgeries involve higher risk of infection and complication (Calne, 2006). The final and most significant negative aspect of the wide elliptical excision surgery is the large scar; the larger incision and the greater requirement for sutures results in a longer scar, and more scar tissue forming to bridge the gap between the two widest areas on the ellipse (Jun et al., 2010). The massive scar makes this procedure very unfavorable as the population becomes more scar-conscious (Nakamura, 2001).

Although it involves a higher risk of recurrence, the overall more applicable and useful method of cyst removal is through minimal excision. Both can be useful; for example, minimal incision is preferable for inflamed cysts, while elliptical excision is preferable when infection or physical damage has broken the cyst wall (Sempowski, 2006). Ceding that minimal incision is not ideal for the largest of cysts, and considering that both surgeries can be useful in different situations, minimal incision is still the better choice. Both surgeries have a similar negative aspect: minimal incision risks recurrence while wide excision risks infection. Meanwhile, minimal incision has the stronger positive aspects; it leaves a scar that's small and barely noticeable, and it's intrinsically less invasive. In addition, minimal incision is the easier procedure: the smaller incision and the mostly visual nature of the surgery makes success more likely among inexperienced surgeons. There are quite a few instructional videos available to aid in showing inexperienced surgeons the physical maneuver of effectively squeezing out a cyst, but making a correct large elliptical excision is something that requires lots of practice, and which may result in more complications. Since epidermoid cysts are usually benign, there haven't been advancements in their treatments since the 2009 laser punch surgery, but as our medical technology develops, hopefully a more efficient method of removing the cyst wall will be identified.

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