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## Ear piercing techniques and their effect on cartilage, a histologic study

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**Summary** *Background:* The popularity of high ear piercing has led to an increased incidence of perichondritis. Damage to the relatively avascular cartilage will make the ear prone to infection. The literature suggests that a piercing gun, mainly used by jewellers to pierce the lobe, may give excessive cartilaginous damage. Therefore some authors favour the piercing needle, as used in piercing studios. But until now, no comparative histological studies have been performed.

*Purpose of study:* To evaluate the extent of damage to ear cartilage using different piercing techniques.

*Methods:* Twenty-two fresh human cadaver ears were pierced using two spring loaded piercing guns (Caflon and Blomdahl), one hand force system (Studex) and a piercing needle (16G i.v. catheter). Extent of damage to the perichondrium and cartilage was quantified using a transverse section along the pin tract and compared between the different methods.

*Results:* The pattern of injury was similar in all techniques, showing perichondrium stripped from the cartilage around the pin tract, with most damage present on the exit site (mean length of 0.43 mm). Cartilage fractures and loose fragments were present over a mean length of 0.21 mm. No significant difference in the amount of injury between the different techniques was observed.

*Conclusions:* In contradiction with assumptions in the literature, all piercing methods give the same extent of damage to cartilage and perichondrium. Each method is expected to have the same risk for perichondritis, thus in the prevention of post-piercing perichondritis focus should be on other factors such as hygiene and after-care.

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High ear piercing has become a popular form of body jewellery since the last decade of the 20th century. Estimates of ear piercing manufacturers are that, at present, about 30% of all ear piercings in Europe involve

piercing of the upper, cartilaginous area of the ear. Following this increase in popularity, a series of reports on perichondritis in just-pierced ears, and subsequent ear deformity and reconstruction were published.<sup>1-4</sup> In England and Wales the incidence of auricular perichondritis doubled between 1990 and 1998.<sup>5</sup>

The early features of perichondritis include local heat, erythema and pain, followed by swelling of the infected ear and abscess formation. Despite antibiotic and surgical intervention chondral necrosis occurs, leaving behind a residual deformity of the ear, for which plastic surgical reconstruction is often sought.<sup>1,2</sup> *Staphylococcus aureus* or *Pseudomonas aeruginosa* are mainly cultured from the perichondral abscesses, but infection with *Streptococcus* or *Proteus* species have also been reported.<sup>1-4,6</sup>

Although the minor complication rate in high ear piercing does not exceed the rate of piercing of the lobule of the ear,<sup>7</sup> the outcome after infection can be far worse. High ear piercings were far more susceptible to infection in a case-control study of a large outbreak of *Pseudomonas* infection after piercing (caused by contaminated after-care solution).<sup>4</sup>

This more dramatic course is the result of the unique characteristics of the cartilage. The cartilage is relatively avascular, only nourished by its perichondrium. Trauma by piercing will devascularise it even further. Bacteria, introduced through the piercing pin tract, will find a good medium for infection and can proliferate unchecked by the body's immune system.

It is often suggested that spring-loaded piercing guns, mainly used by jewellers, will cause excessive damage to the cartilage; a relatively blunt stud is forced through skin and cartilage by unloading of a strong spring, thus applying sheer forces to the cartilage with risk of shattering and stripping off of the perichondrium, making the ear prone to infection.<sup>1,3,6,8,9</sup> Professional piercers use disposable intra-venous (i.v.) cannula to pierce ears; in their opinion this is a far less traumatic technique.<sup>9</sup>

An alternative technique is a system in which the piercing stud is pushed through the tissue by hand force, therefore applying a more dosed force.

The Dutch Ministry of Health, Welfare and Sport is preparing new regulations for piercing and tattoos, and was considering a ban on spring-loaded piercing guns for high ear piercings based on the present literature. However, the assumptions on tissue trauma through the different piercing methods have never been tested; a study identifying the method of piercing least traumatic to the ear is needed. In this report we have studied the direct effect of different ear-piercing techniques on ear cartilage in a human cadaver study.

## Materials and methods

The ears of 22 freshly defrosted un-impregnated cadavers were pierced at room temperature. Left or right ear was used, avoiding the ear with post mortem haemorrhages or oedema. The antihelix of the ears was pierced using four different methods, leaving four piercings per ear. Direction of force was from anterior to posterior in all methods. After piercing, the ears were emerged in 4% formalin for fixation.



**Figure 1** Traditional open spring-loaded piercing gun US. Patent 4020848 + Caflon 1.20 mm diameter studs.

Before embedding the tissue in paraffin, the anterior surface was marked with ink. The specimens were anonymously coded and the code was sealed to assure 'blind' histological assessment. A series of transversal slides were made parallel through the hole and stained with hematoxylin & eosin.

## Different piercing methods

### Spring-loaded piercing gun, two types were tested:

A. Traditional open spring-loaded piercing gun (US. Patent 4020848 filed July 25 1973). Using Caflon 1.20 mm diameter studs (Caflon, Aylesbury, Bucks, UK).

This model was in use until recently in a local jeweller's store, which specialised in earrings. Stud and clasp are loaded from a sterile cassette, without touching the (non-sterile) gun. Piercing was performed following instructions for use (Figure 1).

B. Blomdahl, spring-loaded piercing gun and disposable ear piercing cassettes containing 0.70 mm diameter studs (Blomdahl Medical AB, Halmstad, Sweden). The closed



**Figure 2** Spring-loaded piercing gun Blomdahl.



Figure 3 Push through system, Studex.

sterile complex of stud, stud holder, clasp and clasp holder is placed on the piercing gun. Piercing was performed following instructions for use (Figure 2).

**Hand force system**

System 75 by Studex. Disposable Cartridge Ear Piercing System and disposable cartridges containing 0.75 mm studs (Studex Inc, Gardena, USA). The closed sterile complex of stud, stud holder, clasp and clasp holder is placed on the push-through instrument. Piercing was performed following instructions for use (Figure 3).

**Needle**

BD Insyte-W i.v. catheter 16G 1.7 mm diameter (Becton Dickinson Infusion Therapy Systems Inc., Sandy, Utah, USA). Intravenous catheter used in the University Medical Centre Utrecht, comparable to i.v. catheter used in local piercing studios for ear piercing. Technique as used in local piercing studio: complex of needle and catheter is pierced through the ear at a 90° angle, while fixating the ear with forceps with two broad, flat, open tips, leaving a 'window' for the needle. The needle is removed,

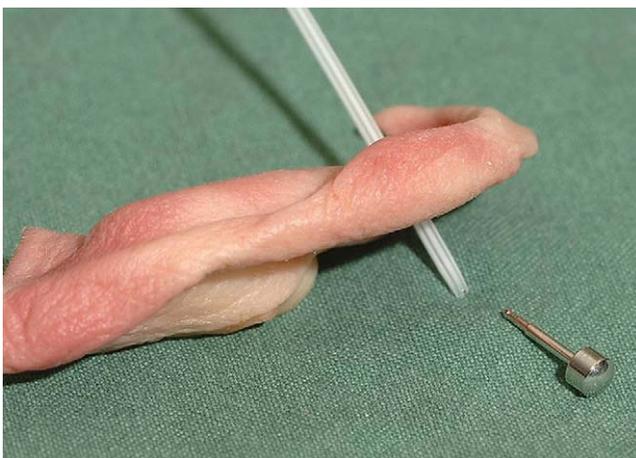


Figure 4 Needle piercing.

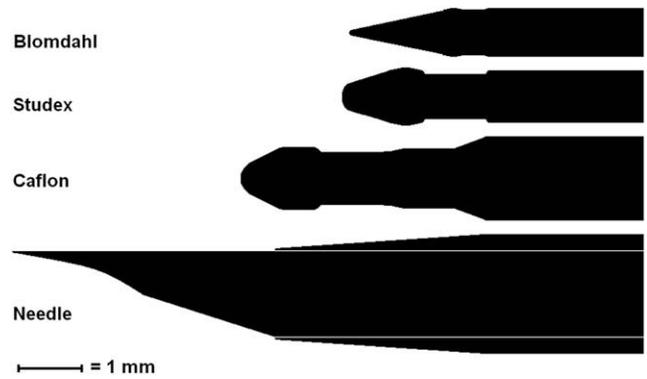


Figure 5 Detail of the used piercing studs/needle.

leaving the catheter in place, and the stud is introduced (1.20 mm stud). With the stud in place, the catheter is removed, and the clasp added to the stud by hand (Figures 4 and 5).

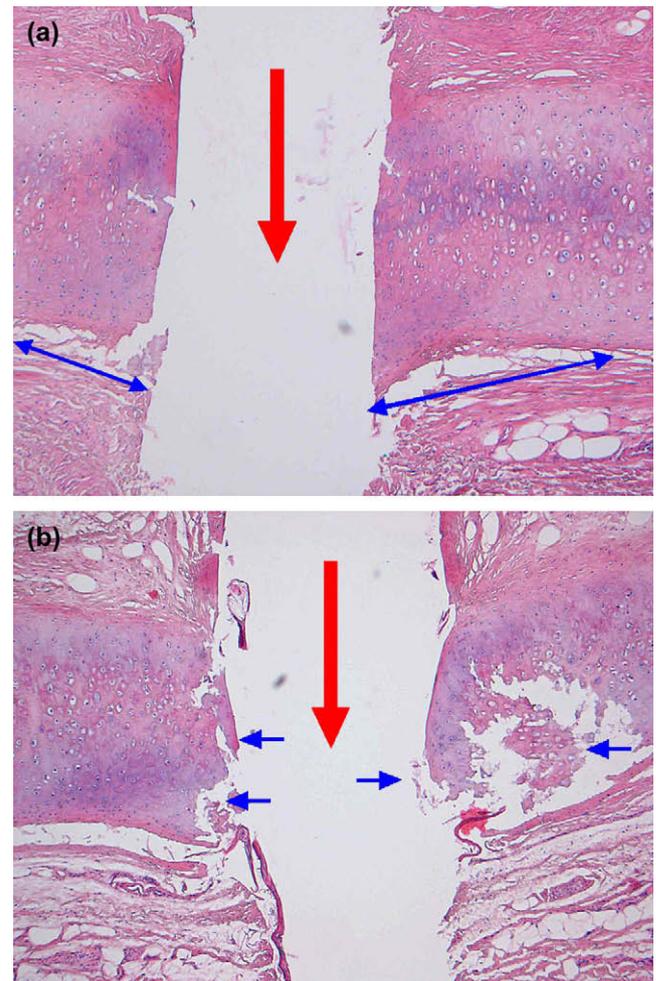


Figure 6 (a, b) Example of injury patterns within (a): mainly perichondrial detachment (small arrows); (b) mainly fragmentation of cartilage (small arrows). Big arrows: direction of piercing; from anterior to posterior (slide through hole, x50, light microscopy, hematoxylin & eosin staining).

**Table 1** Total perichondrial damage

Measurements	Needle	Blomdahl	Caflon	Studex	Total
Mean (mm)	1.36	1.16	1.56	1.34	1.37
SD	0.66	0.52	0.59	0.82	0.67
Range (mm)	0.14–2.52	0.46–2.14	0.56–2.98	0.12–3.40	0.14–3.40

Total perichondrial damage: sum of lengths over which detachment of perichondrium is present on both sides of the pin tract, anterior and posterior.

## Histology and quantification of tissue damage

With light microscopy ( $\times 50$  magnification) the transverse section through the pierced hole in the ear shows the auricular cartilage covered by perichondrium and surrounding subcutaneous tissue and anterior and posterior skin. The pin tract is central to this (see Figure 6a, b).

For each piercing the slide with the best, largest trans-section through the pin tract was selected for measurements, a scale in the ocular of the microscope was used to measure the extent of tissue damage (at  $\times 50$ , one scale grade = 0.02 mm).

Special attention was paid to borders between cartilage and perichondrium. Along this border the length over which detachment of perichondrium is present was measured on both sides of the pin tract, at both the anterior and posterior border. The sum of these four lengths was taken as a measure of perichondrial damage (further mentioned as total perichondrial damage).

Tears in the cartilage itself were also observed: the maximum distance from the pin tract, at a  $90^\circ$  angle at which a tear is found, was measured on both sides of the tract. The sum of these two maximum lengths was taken as a measure of cartilage tears (further mentioned as total chondral tears).

Loose cartilage fragments or cartilage flaps were counted and taken as a measure of chondral shattering.

Thickness of both ear and cartilage were measured.

Measuring points were beforehand set by a pathologist (J.A. Kummer). Measurements are made in a 'blind' fashion as the specimens, beforehand, were anonymously coded and the code was sealed until statistical analysis.

Data were entered in the SPSS 13.0 database. The four groups were compared for each variable using univariate analysis of variance. One-way ANOVA and post hoc multiple comparisons (Bonferroni) were used, correcting for the random effect 'ear'.

## Results

Twenty-two ears were pierced with 22 needle piercings, 22 hand force piercings (Studex), 22 Caflon spring-loaded

piercing gun piercings and 20 Blomdahl spring-loaded piercing gun piercings (only 20 available).

In nine instances, tissue slides were made beyond the pin tract, thereby failing to include the point of passing through the cartilage. In one ear all four different piercings were lost this way. The other losses were: four extra Blomdahl specimens and one extra hand force piercing (Studex) specimen. This left 21 needle piercings, 20 hand force piercings (Studex), 21 Caflon spring-loaded piercing gun piercings and 15 Blomdahl spring loaded piercing gun piercings available for measuring.

All slides showed excellent histology; the extent of tissue damage due to piercing was easily recognisable and measurable. Thickness of the cartilage at the four different piercing sites along the antihelix, was consistent in each ear although thickness of the subcutaneous tissues slightly varied.

Specimens showed a similar pattern of injury at the piercing site.

Damage to the epithelium is minimal, occasionally a strip of epithelium is pulled along the pin tract into the subcutaneous tissue. Injury to the subcutaneous tissues is limited to the area directly surrounding the pin tract. At point of entry in the cartilage there is an impression of cartilage and often the perichondrium is torn from the cartilage over a small distance (mean length: 0.26 mm; min 0.00 mm, max 1.50 mm). Most of the cartilage tears and fragments are found in the middle and posterior parts of the cartilage (mean length 0.21 mm; min 0.00 mm, max 2.15 mm). Often the edges of the cartilage along the pin tract are bent to the posterior. At the posterior side, where the pin tract exits the cartilage, the perichondrium is torn off the cartilage over a longer distance (mean length 0.43 mm; min 0.00 mm, max 2.00 mm) (Figure 6a, b).

## Measurements and statistics

The four groups were compared for each variable, as mentioned in Tables 1, 2 and 3, using univariate analysis of variance.

One-way ANOVA and post hoc multiple comparisons (Bonferroni) were used (correcting for the random effect

**Table 2** Chondral tears

Measurements	Needle	Blomdahl	Caflon	Studex	Total
Mean (mm)	0.46	0.36	0.38	0.46	0.42
SD	0.32	0.29	0.23	0.55	0.37
Range (mm)	0.08–1.18	0.00–1.10	0.06–0.96	0.06–2.50	0.00–2.50

Total chondral tears: sum of max. length on both sides of pin tract in mm.

**Table 3** Cartilage fragments

Measurements	Needle	Blomdahl	Caflon	Studex	Total
Mean (sum)	3.81	4.19	5.52	4.90	4.63
SD	4.06	3.58	4.00	3.93	4.17
Range (sum)	0–16	0–12	0–19	0–18	0–19

Number of loose cartilage fragments or flaps along the pin tract.

'ear'). Errors of all three variances were normally distributed.

Comparison of one group against the total of measurements (one-way ANOVA), as well as multiple comparisons between the different groups (Bonferroni) did not show any significant difference for the means of total perichondrial damage, total chondral tears or chondral shattering.

### Additional measurements

Perichondrial damage on the posterior (exit) site seems more extended than on the anterior site. The percentage of perichondrial damage at the posterior border compared to the total damage is expressed in Table 4. This tendency towards posterior damage was tested using the one sample *t*-test, with 50% as the test value.

This tendency was significant for the Caflon spring-loaded piercings, Studex hand force system and total.

### Discussion

Choosing the least traumatic piercing method could reduce the risk of post-piercing perichondritis. It is often suggested, although never tested, that piercing guns will cause excessive damage to the cartilage. Our human cadaver study of commercial piercing techniques of the upper ear and their direct effect on cartilage evaluated this assumption and provided more clarity on the effects of piercing to the ear cartilage in general.

The direct post-piercing tissue injury pattern, consistent through the slides, shows perichondrium torn from the cartilage and some tears and fragments of the cartilage. Injury to the subcutaneous tissues was limited. Most of the damage, both at perichondrial and cartilage level, is at the side where the piercing stud exits the cartilage. Tissue injury was seen over a relatively small distance; 2.12 mm from the pin tract is the maximum length measured, and the average is much lower.

The extent of the damage is modest, nevertheless the aspect of the tissue injury pattern may be of importance. The perichondrial detachment creates a pocket between the perichondrium and cartilage. This pocket could facilitate the development of a subperichondrial abscess. It is also unfortunate that most of the damage is to the posterior site of the ear, where self-cleaning is less easy to perform.

A comparison between the different piercing methods did not show any significant difference in perichondrial damage, total chondral tears or chondral shattering, despite the fact that the design and diameter of the tip of the piercing instrument varied greatly, as well as the force applied to pierce the ear.

This study was not meant to develop the ideal piercing method, but the fact that the needle, having a much larger diameter than the other studs, showed the same amount of damage suggests that the best results can be expected from a sharp piercing instrument with a relatively small diameter. Maybe results of the needle piercings can be improved by removing the (relatively blunt) i.v. catheter, to introduce the stud in the needle instead, although then a larger diameter needle is needed.

Maybe the results of the direct piercing methods (spring loaded and hand force) can be improved by sharpening the tips of the stud.

There does not seem to be an advantage in a dosed force, as used in the hand force system, compared to the spring-loaded guns.

A cadaver study, of course, does not provide the possibility of following the response to injury after piercing. As the direct injury pattern is the same for the different piercing methods, the following events of bleeding, inflammation and healing are expected to be similar. But what might be of importance is the room left between the stud and the pin tract. The needle piercing method makes a larger diameter pin tract for a smaller diameter stud. In the piercing gun and hand force methods the stud directly pierces the ear, leaving no extra space. In these methods secondary pressure necrosis might occur. But in the 'loose' needle pin tract there is more room for debris. Both can give an additional risk for secondary infection. Only animal studies at different time-points can study these effects.

In conclusion, what this study does show is that the currently available methods to pierce the upper-ear are comparable with regard to direct tissue damage. Based on this, each method is expected to give the same risk for perichondritis. This means that if we want to reduce the risk of post-piercing perichondritis the focus should be on other risk factors: hygiene during the procedure and in after care. Hygiene is always important, but is vital in piercings through cartilage as the nature of the

**Table 4** Perichondrial damage at the posterior border

Measurements	Needle	Blomdahl	Caflon	Studex	Total
Mean (%)	62.5	63.3	64.3	70.1	65.1
SD	20.9	25.0	20.8	22.3	21.8
Range (%)	15.7–88.7	18.2–96.2	16.7–94.9	21.1–100	15.7–100
<i>P</i> Value	0.012	0.059	<i>P</i> < 0.001	<i>P</i> < 0.001	<i>P</i> < 0.001

Perichondrial damage at posterior border, percentage of total perichondrial damage.

post-piercing tissue damage, although small, facilitates perichondritis.

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**Products:** The Blomdahl spring-loaded piercing gun and disposable ear piercing cassettes and System 75 by Studex Push Through Disposable Cartridge Ear Piercing System and disposable cartridges (Studex Inc., 521W. Rosecrans Ave. Gardena, CA 90248-1514, USA) were kindly provided by: Blomdahl Medical AB, Kristinebergsvägen 18, P.O. Box 7032, SE-300 07 Halmstad, Sweden

Traditional open spring-loaded piercing gun (US Patent 4020848 filed July 25 1973) + Caflon ear piercings (Caflon, Unit 19, Park Street Industrial Estate, Osier Way, Aylesbury, Bucks HP20 1EB, UK) were kindly provided by the owner of a local jewellery store (specialised in earrings) 'Het Oortje' Oudegracht184, 3511NP Utrecht, The Netherlands.

Studio Remi – Piercing & Tattoo art, Utrecht, the Netherlands provided information on needle piercing, the needle piercing in this study was conducted according to their method.

**Role of the sponsors:** The sponsoring agencies had no involvement in the design, conduct or write-up of this study.

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