An analysis of quantitative measurements of drainage exudate using negative suction in 96 microtia ear reconstructions

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Negative suction drainage is commonly used for the prevention of seromas or hematomas in auricular reconstruction surgery; however, there are few reports regarding the quantitative measurement of negative suction and its relation to disposed time, patient age or microtia type. In the present study, the authors recorded the volume of suction exudate in microtia reconstruction and elaborate on the relevant details of controlling negative suction. A negative suction drainage system was applied in 96 microtia patients between 2007 and 2010. Two small polyethylene drains were inserted adjacent to the concha and the scapha, respectively. The volume of exudate was recorded for three days after surgery and was analyzed according to disposed time, patient age and microtia type. The drains were removed on the third postoperative day, when only a small amount of exudate remained. A significant change in drainage was observed over three days postoperatively, and the quantity decreased progressively on the third postoperative day. Comparison of age groups showed that the volume of drainage from adults was greater than that from children or adolescents in the first two postoperative days, regardless of whether the drains were inserted in the scapha or concha. No statistical differences were found on the third postoperative day. A comparison of drain types revealed no statistically significant differences between scapha and concha drains three days postoperatively. The analysis demonstrated that drainage quantity is related to disposed time and patient age, but not to microtia type. The authors recommend removal of suction drains on the third postoperative day. Moreover, individualized negative suction treatment according to age or microtia type provides a safe and consistent approach to achieving acceptable results and fewer complications.

Key Words: *Ear reconstruction; Microtia; Negative suction; Quantity measurement*

Une analyse des mesures quantitatives du drainage des exsudats par pression négative après la reconstruction auriculaire de 96 microties

Le drainage par pression négative est souvent utilisé pour prévenir les séromes ou les hématomes après une chirurgie de reconstruction auriculaire, mais peu de rapports portent sur la mesure quantitative de la pression négative et sur son lien avec la durée du drainage, l'âge du patient ou le type de microtie. Dans la présente étude, les auteurs ont consigné le volume des exsudats par pression après une reconstruction de microtie et exposé l'information détaillée pertinente pour contrôler une pression négative. Ils ont utilisé un système de drainage par pression négative chez 96 patients opérés à cause d'une microtie entre 2007 et 2010. Ils ont inséré deux petits drains de polyéthylène adjacents à la conque et à la fossette scaphoïde, respectivement. Ils ont consigné le volume d'exsudat pendant trois jours après l'opération et l'ont analysé d'après la durée du drainage, l'âge du patient et le type de microtie. Ils ont retiré le drain trois jours après l'opération, lorsqu'il ne restait qu'une petite quantité d'exsudat. Ils ont observé un changement important du drainage pendant la période de trois jours suivant l'opération, et la quantité a décru progressivement le troisième jour. En comparant les groupes d'âge, ils ont démontré que le volume de drainage est plus important chez les adultes que chez les enfants ou les adolescents pendant les deux premiers jours suivant l'opération, que les drains soient insérés dans la fossette scaphoïde ou la conque. Ils n'ont toutefois constaté aucune différence statistique. La comparaison des types de drain n'a révélé aucune différence statistiquement significative entre les drains dans la fossette scaphoïde ou la conque trois jours après l'opération. L'analyse a démontré que la quantité de drainage est liée à la durée du drainage et à l'âge du patient, mais pas au type de microtie. Les auteurs recommandent de retirer les drains de pression le troisième jour postopératoire. De plus, un traitement par pression négative personnalisé selon l'âge ou le type de microtie constitue une démarche sécuritaire et uniforme pour obtenir des résultats acceptables et réduire les complications.

Due to its complex, three-dimensional morphology, auricular reconstruction remains one of the most challenging procedures in reconstructive surgery. A successful auricular reconstruction demonstrates good comparability in accentuated contour, which relies mostly on tight contact between the skin flap and the implanted cartilage framework. A negative suction drainage system provides a simple, safe and consistent approach to achieving a smooth contour in auricular reconstruction. In previous studies (1-3), a single tube, or two silicone drains and disposable syringes, have been successfully used in ear reconstruction procedures as a negative suction drainage system. To date, few reports have focused on quantitative measurement of negative suction and its relationship to disposed time, patient age or microtia type, all of which are very important to negative suction regulation. The aim of the present study was to carefully record the volume of suction exudate from 96 microtia patients and determine whether relationships among patient age, microtia type and postoperative time exist.

METHODS

A total of 96 microtia patients, ranging in age from six to 26 years, underwent reconstruction using autogenous costal cartilage between 2007 and 2010. Fifty-eight cases were right sided, 36 cases were left sided and two cases were bilateral. Seventy-seven patients were male and 19 were female. According to accepted microtia classifications, 61 cases were lobular and 35 were concha type. Forty-two patients were children between six and 12 years of age, 27 adolescents were between 13 and 17 years of age and the remaining 27 patients were adults (Table 1).

The sixth, seventh and eighth costal cartilages were harvested from the contralateral chest according to the method of Tanzer (4), and modified using the Brent (5) and Nagata (6-8) techniques. The sixth and seventh costal cartilages were used for reconstruction of the base frame, while the eighth costal cartilage was used to construct the helix and crus helicis. The assembled cartilage framework was then placed

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TABLE 1
Patient characteristics

	Patients, n (%)
Microtia	
Right	58 (60.4)
Left	36 (37.5)
Bilateral	2 (2.1)
Sex	
Male	77 (80.2)
Female	19 (19.8)
Type	
Concha	35 (36.5)
Lobule	61 (63.5)
Age, years	
6–12	42 (43.8)
13–17	27 (28.1)
≥18	27 (28.1)

into a subcutaneous pocket resulting from the careful removal of all cartilage remnants, as reported previously (9-11).

Two small polyethylene drains with multiple perforations located near the end were used for occlusion of the skin flap to the fabricated cartilage framework. To ensure that it was not placed directly beneath the framework, the drain adjacent to the concha was inserted from an incision inside the preauricular hairline and placed in the gap between the tragus and antihelix of the framework. The other drain was inserted at the scapha. Both of the drains were fastened securely to the skin near the incision with 6/0 nylon sutures. The drains were then connected to a 20 mL disposable syringe consisting of a piston and a needle cover, which delivered continuous negative suction. After achieving the proper tension, the position of the piston was fixed with the needle cover. Negative pressure can be controlled by syringes of different capacity and the length of the needle cover (Figure 1). The absence of leakage was confirmed before the operation was performed, and fine adjustments were made to even out the skin over the frame. All of the incision lines were covered with ointment. No dressing or cover was necessary on the constructed ear, enabling convenient observation of skin coaptation and skin flap blood supply. It is vital to change the two syringes every 30 min during the first 2 h, then every 2 h thereafter. Meanwhile, the volume of exudate was recorded for three days after surgery; also included were observations of the auricular shape and the blood supply of the skin flap. The drains were removed on the third postoperative day, when only a small volume of drainage exudate remained and was recorded.

Because the original data were not normally distributed, all analyses were based mainly on nonparametric methods. Kruskal-Wallis tests and Wilcoxon rank-sum tests were performed to compare scores on different days and patient age. Wilcoxon rank-sum tests were used to compare scores of different microtia types and $P<0.05$ was considered to be statistically significant. All statistical analyses were performed using SPSS version 16 (IBM Corporation, USA). Statistical summary data are graphically presented using box plots.

RESULTS

From 2007 to 2010, a total of 96 consecutive microtia patients were treated accordingly. The quantity of drainage from 85 cases was measured and recorded, with 11 cases excluded (Table 2).

As shown in Table 2, the drains were closed on the second postoperative day in four cases and, in two other cases, only one polyethylene drain was applied adjacent to the concha because of high tension in the skin flap. Hematomas occurred in two cases approximately 2 h postoperatively. After hematoma evacuation and chloromycetin washing, the drains were reinserted adjacent to the concha and scapha for continuous negative suction drainage. A particularly high volume of serum exudate appeared in three cases during the first two postoperative days.

TABLE 2
Special cases summary

Patient	Side	Sex	Age, years	Microtia type
Drain closing				
1	Right	Male	7	Lobular
2	Right	Male	10	Lobular
3	Left	Male	20	Concha
4	Right	Female	26	Concha
Single drain				
5	Left	Male	7	Lobular
6	Left	Male	18	Lobular
Hematoma				
7	Right	Male	7	Concha
8	Right	Male	15	Lobular
Seroma				
9	Right	Male	10	Lobular
10	Left	Female	16	Concha
11	Left	Male	19	Lobular

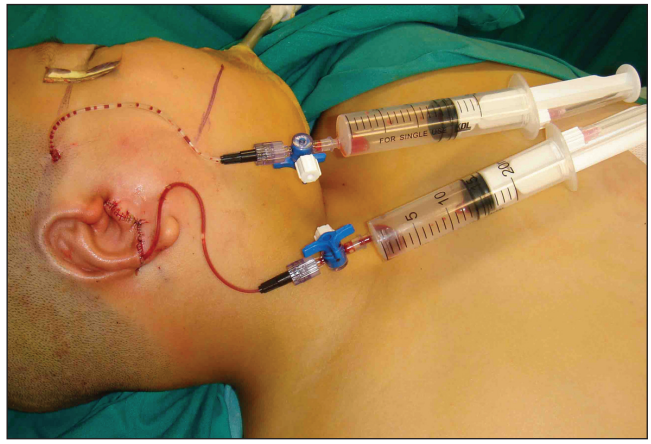

Figure 1) *Two small polyethylene drains with multiple perforations were used for occlusion of the overlying skin flap to the framework. One was inserted adjacent to the concha and the other was inserted at the scapha. Two 20 mL disposable syringes were connected to these drains. The piston was fixed in position with a needle cover*

In these cases, 20 mL syringes were replaced with 50 mL syringes and changed every 30 min. The volume of exudate from each drainage was significantly lower on the third postoperative day.

In the remaining 85 cases, significant differences in drainage quantity were observed in the first three days postoperation, regardless of whether the drain was placed in the scapha or concha ($P<0.05$). The quantity of drainage decreased progressively, with only a small amount recorded on the third postoperative day (Figure 2, Table 3).

The comparison of age groups showed obvious differences during the first two postoperative days: drainage volume from the scapha drain in adults was greater than that for children or adolescents ($P<0.05$) (Figure 3A left). Consistent results were observed in drainage volumes of concha drains (Figure 3 right). No statistical differences were found on the third posteropative day ($P>0.05$, Table 4).

Comparison of patient groups according to microtia type revealed no obvious differences among the drainage from scapha drain for concha type or lobule type ($P>0.05$, Figure 4 left). Similar results were found in the volume of drainage from concha drains (Figure 4 right). No statistical differences were found on the third postoperative day ($P>0.05$) (Table 5).

When followed-up six months to two years later, most of the reconstructed auricles demonstrated smooth skin contour and good definition of the three-dimensional cartilage framework (Figure 5). One case

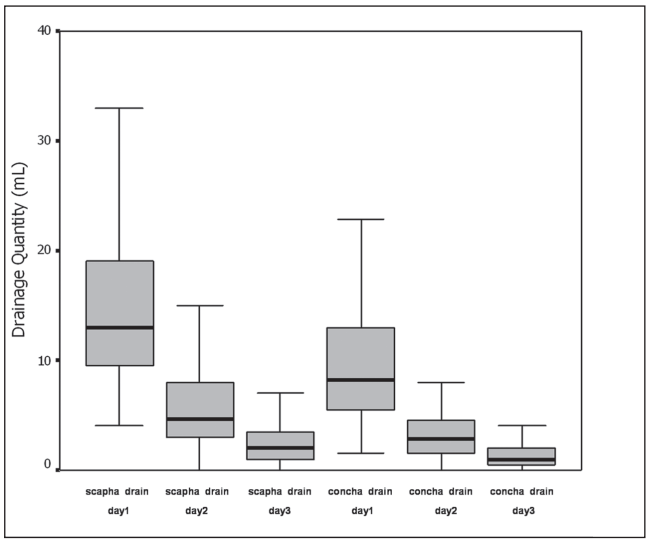

Figure 2) *A box plot comparison of three-day postoperative drainage quantity in scapha and concha drains of 85 microtia patients. The drainage quantity was significantly different three days postoperation, regardless of whether drains were placed in the scapha or concha. It decreased progressively and only a small volume was recorded on the third postoperative day*

TABLE 3
Comparative P values for drainage volumes among the three postoperative days

Drainage position	Kruskal-Wallis test	Day 1 versus day 2*	Day 1 versus day 3*	Day 2 versus day 3*
Scapha	<0.0001	<0.0001	<0.0001	<0.0001
Concha	<0.0001	<0.0001	<0.0001	<0.0001

**Wilcoxon rank-sum tests for multiple comparisons*

control of negative suction failed, showing unfavourable contact between the skin flap and the implanted cartilage framework (Figure 6).

DISCUSSION

Negative suction drainage is commonly used for the prevention of seromas or hematomas in auricular reconstructions; however, there are few articles that feature a discussion of negative suction. We believe that there is worthy information regarding negative suction that is critical to good occlusion between the skin and framework. According to data obtained from our 96 microtia patients, we believe that the individualized negative suction treatment with respect to time, age or microtia type is very important to guarantee acceptable results. In our experience, we believe that more attention should be devoted to the first postoperative day, especially the first several hours after surgery, during which a considerable volume of drainage was recorded. Meanwhile, several uncertain factors and complex variations after the operation, including unstable mood, fluctuating blood pressure, an uncooperative patient, or abrasion between the base tissue and the wire at the bottom of the frame, may result in hemorrhage or hematoma. For the majority of patients, we normally change the drainage syringe every 30 min during the first 2 h, and every 2 h thereafter. Moreover, repeated suction is necessary when the remaining volume of exudate reaches one-third of syringe capacity in a short time, or influences the contact between the skin flap and the framework. In the present study, hematomas occurred in two patients 2 h postoperatively and were treated immediately. Although unusual, drainage in some patients increased dramatically, in which case a 50 mL syringe was used and changed more frequently. Due to the low volume of drainage and favourable occlusion of the skin to the framework, the syringe was changed only when necessary. Therefore, most complications can be prevented by close observation, smooth drainage and diligent care. In

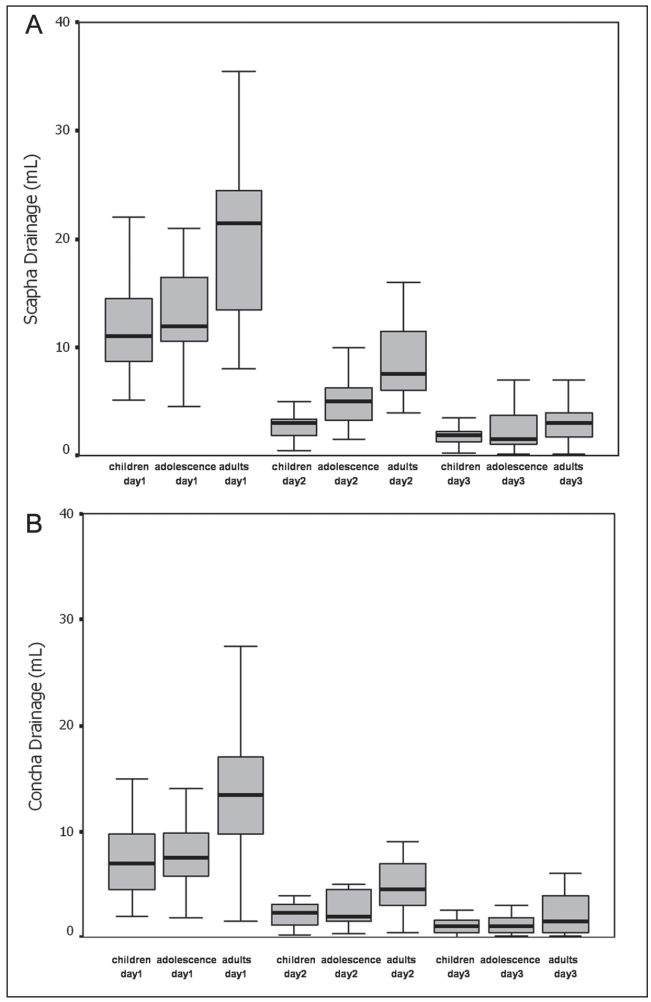

Figure 3) *Boxplot of drainage quantity among patients of different ages. Obvious differences were observed during the first two postoperative days in scapha drains* (**A**)*. The volume of drainage from adults was greater than that of children or adolescents. No statistical differences were found on the third postoperative day. Consistent results were observed in the drainage of concha drain* (**B**)

TABLE 4
Comparative P values for drainage volumes among the three age groups

Drainage position	Post-operative day	Kruskal-Wallis test	Children vs adolescents*	Children vs adults*	Adolescents vs adults*
Scapha	1	0.0002	0.1139	<0.0001	0.0066
Scapha	2	<0.0001	0.0033	<0.0001	0.0045
Scapha	3	0.1026†	0.9828†	0.0404†	0.0948†
Concha	1	<0.0001	0.1486	<0.0001	0.0025
Concha	2	0.0004	0.1217	<0.0001	0.0253
Concha	3	0.1770†	0.7508†	0.0632†	0.1948†

**Wilcoxon rank-sum tests for multiple comparisons; †No statistical differences were found on day 3. vs Versus*

our opinion, postoperative care, especially during the first several hours, is key to an intimate adhesion of the skin to the framework because a good seal can eliminate potential dead space, lessen the danger of seromas or hematomas, and concurrently accentuate the contour of the framework.

We advocate the removal of drains on the third postoperative day. During our study, we observed significant, progressive decreases in the

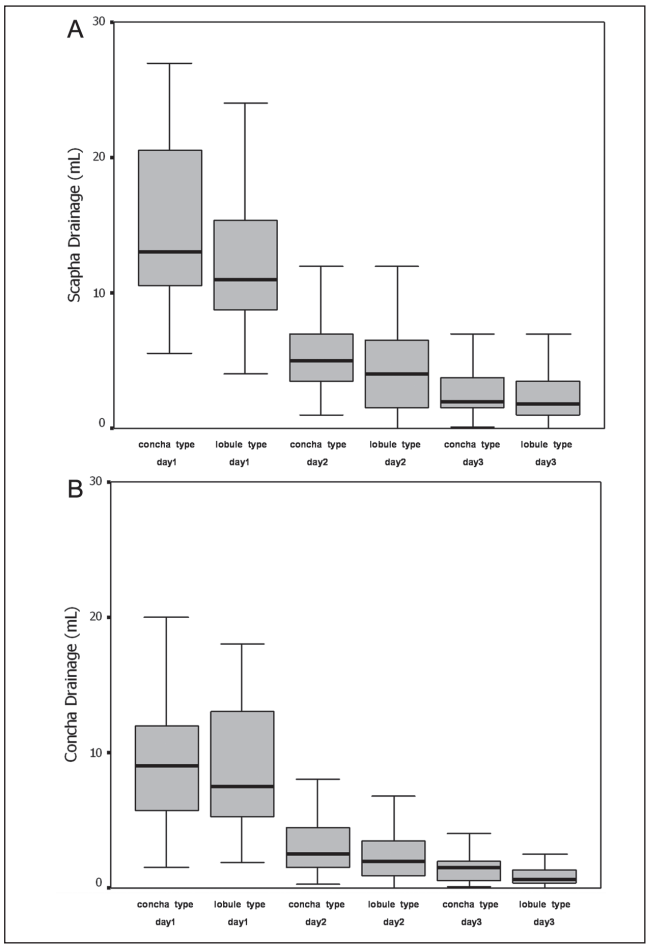

Figure 4) *Boxplot of drainage quantity among patients with different types of microtia.* **A** *and* **B** *No obvious differences were observed in the drainage of scapha drain for concha type or lobule type. Similar results were found in the drainage of concha drain*

TABLE 5
Comparative P values between concha and lobule microtia groups

Drainage position	Postoperative day	Concha versus lobule, P*†
Scapha	1	0.5077
Scapha	2	0.1744
Scapha	3	0.2467
Concha	1	0.9308
Concha	2	0.6772
Concha	3	0.3439

**Wilcoxon rank-sum tests for comparisons; †No statistical differences were found between the two microtia types*

total volume of drainage exudate from the scapha or concha during the first three postoperative days, with only a small amount recorded on the third postoperative day. Therefore, it is unnecessary to leave the drains in much longer. Drain removal facilitated early postoperative patient activity and recovery. No infection occurred in our patients using this method.

Drainage quantity and suction control in patients of different ages are other intriguing topics. In the present study, the volume of drainage from adults was greater than that from children or adolescents, but the negative pressure used in the former was not as much as the latter. We believe that the frequency and strength of suction should be modulated according to the thickness and blood supply of the skin flap of patients of different ages. In adult patients, we observed that excessive negative pressure led to progressively closer occlusion between the skin and framework, even with partial skin flap necrosis because of rough and inelastic skin. In the early postoperative period, the overly tight contact arguably caused an unnatural appearance at follow-up. In contrast, failure of the tight contact occurred in children if strong pressure was not maintained for three days because of their smooth and elastic skin. Furthermore, when the skin adheres snugly to the framework and the drainage quantity is ≤1 mL, it is very important to maintain this state rather than break the balance using excessive suction,

Figure 5) *Three followed-up cases showing smooth skin contour and good definition of the three-dimensional cartilage framework.* **Upper left** *Preoperative photograph of a 12-year-old patient with concha-type microtia;* **Lower left** *Patient nine months postoperation.* **Upper centre** *Preoperative photograph of a 16-year-old patient with lobule-type microtia;* **Lower centre** *Patient one year postoperation.* **Upper right** *Preoperative photograph of a 21-year-old patient with concha-type microtia;* **Lower right** *Patient six months postoperation*

Figure 6) *Case demonstrating failure of negative suction showing unfavourable contact between the skin flap and the implanted cartilage framework. Preoperative photograph of a 21-year-old patient with lobule-type microtia* (**left**) *and six months postoperatively* (**right**)

otherwise, it increases the risk of skin flap necrosis, especially in children. In the present study, a single drain was used in two cases, and drains were closed in another four cases because of quick adhesion of the skin to the framework. Therefore, control of negative suction must be individualized according to the skin characteristics of adults and children.

Obvious differences with respect to exudate quantity in different microtia types were not apparent. During the operation, we found it very difficult to treat cartilage remnants and pocket dissection in concha type microtia and these were accompanied with increased levels of hemorrhage. Nevertheless, careful hemostasis during the operation and meticulous postoperative care may reduce the volume of exudate and decrease the risk of postoperative seromas or hematomas.

Hemorrhagic predisposition is one inevitable factor that may influence operative procedure or postoperative care. Unexpected hemorrhage during the operation is frequently associated with unfavourable characteristics, such as thick accompanying skin with complex chondrocutaneous remnants, or associated serious craniofacial deformities, hypertrophic or keloid scars, anticoagulant use and hepatopathy. However, it is possible to achieve good results by using individualized negative suction treatment together with detailed preparation, cautious performance, precise hemostatis and diligent care.

SUMMARY

Drainage quantity is related to disposed time and patient age, but not to microtia type. It is appropriate to remove the negative suction drain on the third posteropertive day. Moreover, individualized negative suction treatment according to age or microtia type provides a safe and consistent approach to achieving acceptable results and fewer complications.

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