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Endoscopic drainage of orbital abscesses aided with intraoperative sonography

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ABSTRACT

Background and purpose: Accurate localization and adequate visualization of the superiorly or inferiorly located subperiosteal orbital abscesses or intraorbital abscess is difficult with transnasal endoscopic approach. Sonography is a well-known and effective tool for evaluation of orbital pathologies but no paper documenting intraoperative application of this method in orbital abscess surgery has been published to date.

Material and methods: We present a series of 12 patients in whom orbital abscesses were drained endoscopically with an aid of neuronavigation and intraoperative ultrasonography. The abscesses were localized subperiosteally in the medial ($n = 6$), superior ($n = 2$) or inferior ($n = 1$) part of the orbit whereas in 3 patients the abscess was localized in the intraconal space.

Results: According to intraoperative sonographic imaging complete drainage of the abscess was achieved in 11 out of 12 patients and no complications occurred. Intraoperative sonography helped to limit opening of the orbital wall in the medial subperiosteal abscesses, enabled check-up for completeness of drainage of the far extending pouches in the superior and inferior subperiosteal abscesses and enabled visualization of the tip of surgical instrument when reaching deeply located intraorbital abscesses.

Conclusions: Intraoperative ultrasonography facilitates the endoscopic management of orbital abscesses, especially those which are difficult to reach due to subperiosteal location in the superior and inferior parts of the orbit, or abscesses localized intraorbitally.

1. Introduction

Endoscopic drainage is an accepted method of treatment in the case of medially located subperiosteal orbital abscess (SPOA) because endoscopy enables almost uncompromised visualization of the medial orbital wall [1]. However, endoscopic drainage of superiorly or inferiorly located SPOAs or intraconal abscesses raises more controversies as transnasal access to this region is rather limited [2–6].

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Many authors recommend in such cases rather external approaches, the main rationale being problematic localization of the abscess and lack of adequate endoscopic control of the completeness of drainage. This may result in relapse of the disease and necessity of reoperation [7–9]. In previously published reports, the efficacy of drainage was assessed by simple endoscopic observation of puss outflow when pressure was applied on eye globe, by palpation of changing orbital firmness or by estimation of proptosis and eyelid opening at the end of the procedure [7,8,10]. Nevertheless edema and reactive thickening of the extraocular muscles can make such subjective assessment less accurate.

A low invasive reliable bed side imaging is demanded for estimation of drainage efficacy and these conditions are fulfilled by sonography which is a well-known and effective tool for evaluation of orbital pathologies [11–13]. While both preoperative or postoperative use of orbital sonography was previously reported, to the best of our knowledge, no papers documenting intraoperative application of this method were published to date. We present a series of patients in whom intraorbital abscesses were drained endoscopically with an aid of intraoperative ultrasonography.

2. Material and methods

Table 1 shows summary of twelve patients who underwent endoscopic transnasal surgery for SPOA or intraorbital abscess drainage by an interdisciplinary team consisting of ENT surgeon and neurosurgeon between February 2007 and September 2013. Neuronavigation and ultrasonographic guidance was used in all cases. The abscesses were located subperiosteally in the medial ($n = 6$), superior ($n = 2$) or inferior ($n = 1$) part of the orbit whereas in 3 patients the abscess was localized within the intraconal space. The predominant agents from the culture was *S. aureus* in 8 patients, followed by *S. pyogenes* in 2 patients, *S. pneumoniae* in one and *Enterococcus faecalis* in the last one. In all patients different degree of exophthalmos and chemosis was observed preoperatively, accompanied by disturbances of visual acuity. Diplopia was present in all but 2 patients.

2.1. Surgical technique

All the abscesses were drained via transnasal endoscopic approach under intraoperative ultrasonographic control, using 4 mm 0° and 45° endoscopes. In patients with medial SPOAs a standard ethmoidectomy was performed, followed by partial resection of the lamina papyracea, usually starting from the point where pus was oozing from bony dehiscence. In patients with superior or inferior SPOAs, the frontal sinus or maxillary sinus were widely opened, followed by limited resection of the (respectively) superior or inferior margins of the lamina papyracea. A curved blunt suction was used to separate the periorbit from the orbital bony framework to create a tunnel leading laterally to the abscess cavity. Because of an awkward angle of access only medial parts of abscess cavity could be visualized endoscopically in this class of abscesses. Gentle pressure exerted over the orbital content helped to promote puss release, while cautious manipulation with suction tip was continued inside the abscess. Repeated ultrasonographic examination helped in monitoring of gradual decrease of the abscess volume (Fig. 1).

In patients with intraorbital abscesses the periorbit was incised horizontally near the inferior pole of the abscess to allow better postoperative gravitational drainage. An exact site of the incision was determined with a neuronavigation system (Treon Plus, Medtronic). The intraconal space was accessed between the medial and the inferior rectus muscles as described by Karaki et al. [14]. Intraorbital fatty tissues were spread using curved blunt elevator or suction to reach the abscess. Excessive fat tissue prolapsing into the nasal cavity was coped with using cautious bipolar electrocauterization. The position of surgical instruments inside the orbit could be controlled with sonography to avoid creation of the surgical corridor to the abscess in a ''blind manner'' (Fig. 2). One must also take into consideration that endoscopic visualization of the abscess cavity is usually inadequate thus making repeated intraoperative sonography an only means of current control of the efficacy of drainage (Fig. 3).

Nasal packing was avoided except some fibrin sponge placed in the middle nasal meatus at the end of the procedure. Intravenous antibiotic was administered until patient's

Table 1 – Table summarizes information about 12 patients who underwent endoscopic transnasal surgery with the guidance of neuronavigation and intraoperative ultrasonography for orbital abscess drainage.

Case no	Age/ sex	Localization within the orbit	Exophthalmos (mm) pre-op/post-op	Chemosis	Diplopia	Visual acuity pre-op/post-op	Bacterial culture
1	31/M	Medial	5/2	+	+	0.7/1.0	*Staphylococcus aureus*
2	43/F	Superior	6/2	+	+	0.6/0.6	*Streptococcus pyogenes*
3	42/F	Intraorbital	5/1	+	+	0.03/0.1	*Staphylococcus aureus*
4	52/M	Medial	6/1	+	+	0.6/0.6	*Enterococcus faecalis*
5	56/F	Medial	4/3	+	+	1.0/1.0	*Staphylococcus aureus*
6	23/M	Medial	1/0	+	–	0.7/0.7	*Staphylococcus aureus*
7	59/M	Superior	6/1	+	+	0.7/0.9	*Streptococcus pyogenes*
8	15/M	Intraorbital	5/3	+	+	0.7/0.9	*Staphylococcus aureus*
9	42/F	Medial	5/0	+	+	0.5/0.7	*Streptococcus pneumoniae*
10	61/M	Medial	4/2	+	+	0.7/0.7	*Staphylococcus aureus*
11	47/M	Inferior	5/1	+	–	0.7/0.7	*Staphylococcus aureus*
12	46/M	Intraorbital	4/2	+	+	0.4/0.9	*Staphylococcus aureus*

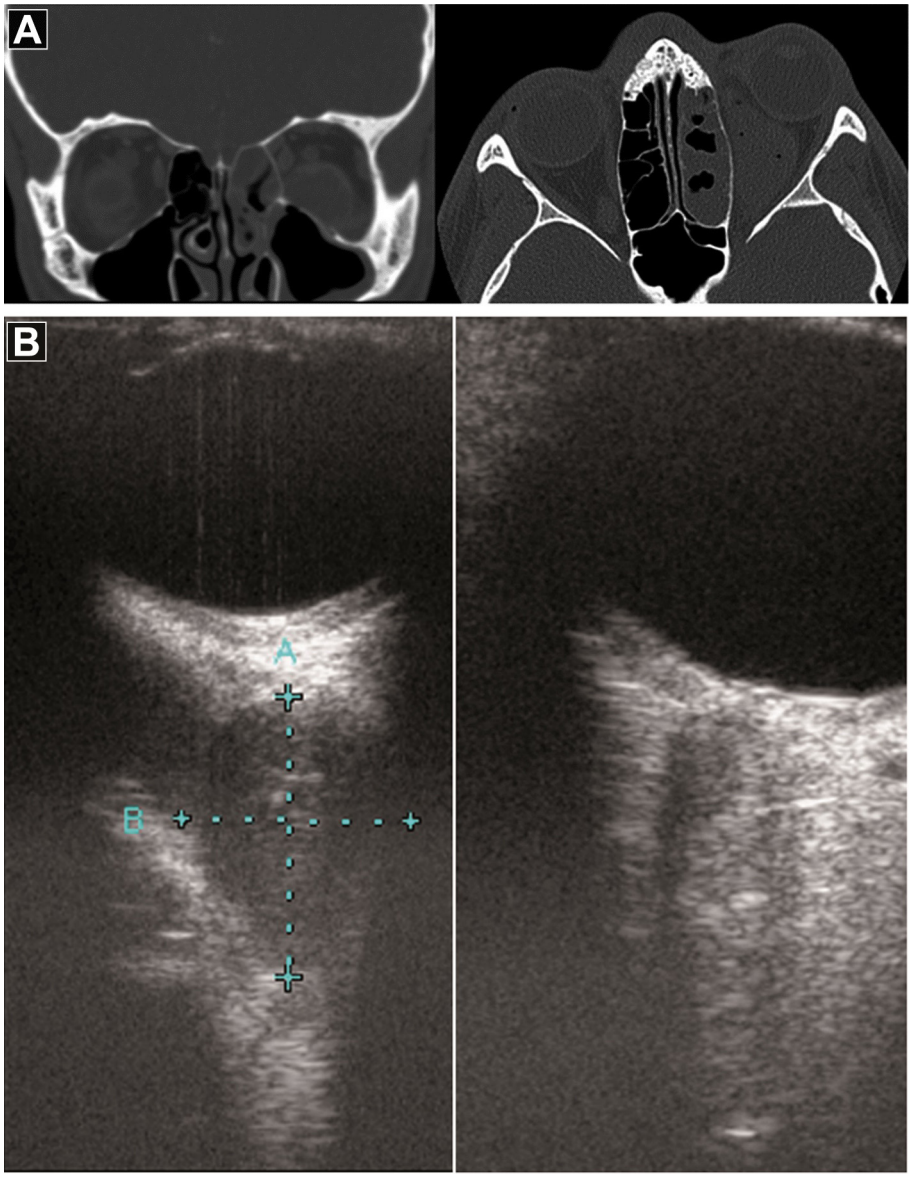

Fig. 1 – (A) Preoperative CT of inferior subperiosteal abscess: coronal (left) and axial plane (right). (B) Intraoperative ultrasonographic examination of the same patient. The affected orbit before drainage (right) and after complete drainage (left).

discharge then followed by its oral administration for the next ten days. Ophthalmological follow-up was performed at 48–72 h after surgery and included orbital ultrasonography for potential puss re-accumulation.

2.2. *Intraoperative sonography*

Intra-operative (i.op.) examination of the orbit was performed by an experienced sonologist with Aplio SSA device (Toshiba). A 11–14 MHz linear transducer, covered with a sterile latex sheath filled with US-gel was placed for the examination on the superior eye lid. The assessment was repeated several times during the procedure and then continued as post-operative follow-up on daily basis. First examination was performed immediately before resection of the lamina papyracea to obtain initial image of the intraorbital structures. In a case of medially located SPOAS, a ''sonographic check-up'' was performed only after complete evacuation of the puss. When dealing with superior/inferior SPOAs and with the intraorbital abscesses the entire process of abscess emptying was controlled with sonography, i.e. the examination was repeated as many times as necessary to make sure that the abscess had been drained out completely.

As mentioned above, when dealing with an intraorbital pathology, the entire path of the surgical instrument to the intraorbital abscess was guided with sonography. This merit of i. op. sonography proved crucial, because under a pressure of an instrument the capsule of an abscess may only bend inside – instead of being pierced. With no intraoperative updating the surgeon can be (erroneously) convinced that the pathology contains no puss, because neuronavigation system informs in

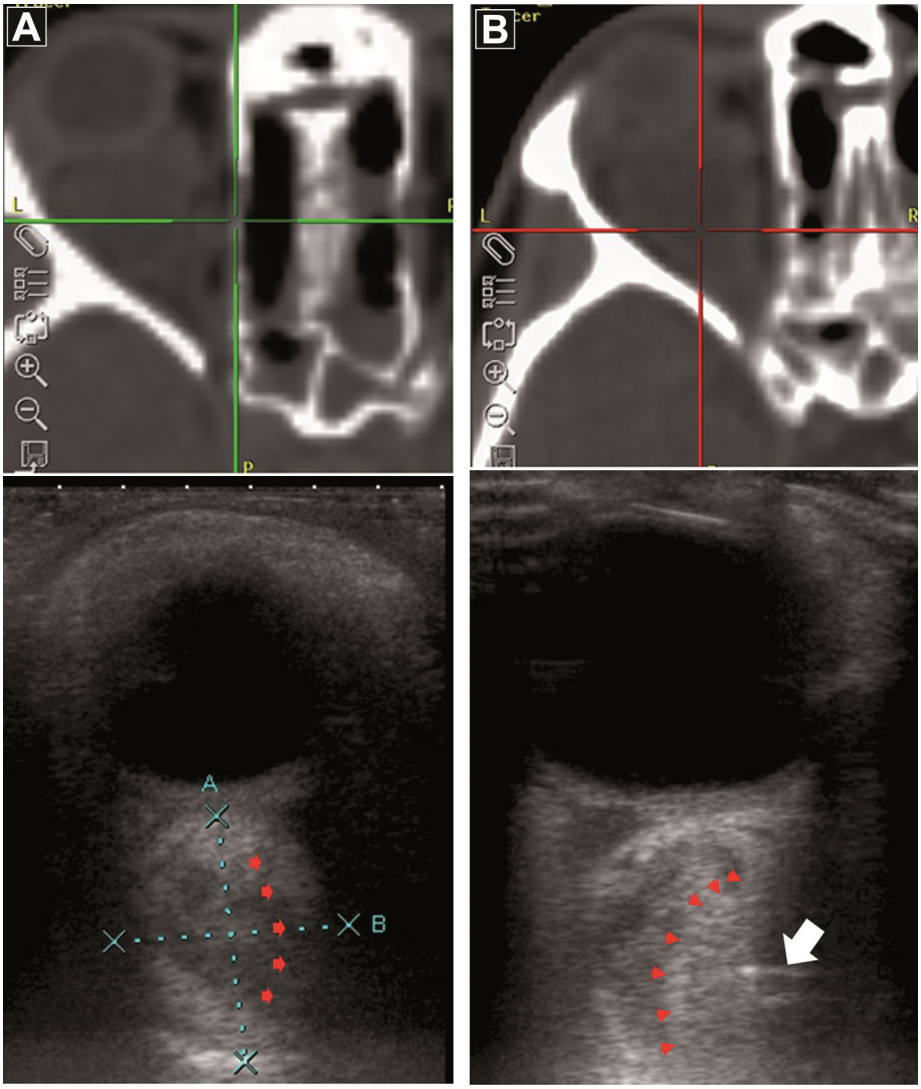

Fig. 2 – An example of confusing intraoperative situation met when dealing with an intraorbital abscess. (A, top) Localization of the tip of a neuronavigated, curved suction tube on the lamina papyracea (green cross) before penetration of the orbit. (bottom) Intraoperative sonographic imaging demonstrates cystic lesion behind the eye-bulb. Red arrows line delineates the medial wall of the abscess. (B, top) Neuronavigation indicates correct placement of suction tip inside the abscess (red cross) but no pus flowed out. (bottom) Intraoperative sonography discloses that the abscess wall (red arrows line) bent under the pressure of the instrument (white arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

this situation that the instrument has reached the interior of an abscess.

3. Results

Neither of the patients suffered from any intraoperative or postoperative complications nor no one required revision surgery. According to itraoperative sonographic imaging complete drainage of the abscess was achieved in 11 out of 12 patients. This result was confirmed with immediate alleviation of orbital firmness and proptosis in 7 patients. In 5 remaining patients there was no difference in firmness of the orbit on palpation before and at the end of the procedure. In those patients a follow-up CT imaging was performed to confirm disappearance of the cystic structure with persisted presence of a different degree proptosis/edema and contracted hyperdense capsule of the abscess. Sonographic follow-up imaging of the orbit in these patients helped to make sure that there was no re-accumulation of fluid which might indicate formation of hematoma or a presence of residual abscess. In all of these patients the symptoms resolved gradually and they were discharged for outpatient department (OPD) within 3–5 days. The follow-up at OPD was continued for the next four weeks.

Intraoperative situation seen in our two patients seems to particularly highlight the utility of i.op. sonographic imaging during abscess evacuation. First case was a regular in shape

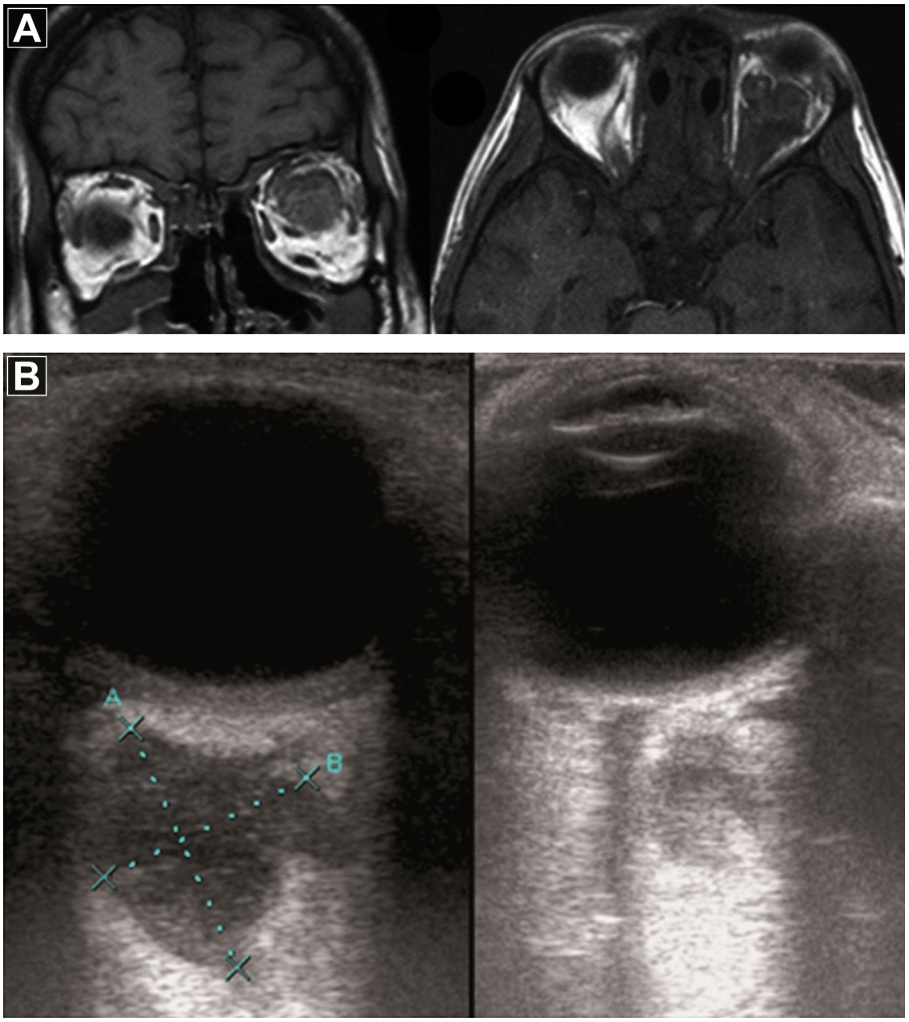

Fig. 3 – (A) Preoperative MRI of intraconal abscess: coronal (left) and axial plane (right). (B) Intraoperative sonography of the same patient shows the affected orbit prior to drainage (left) and after drainage left). The abscess revealed to contain several compartments and one neighboring the optic nerve has not been entered with suction in a fear of damage to the nerve.

intraconal retrobulbar abscess which was approached with the aid of neuronavigation. According to the system indication the suction tip had been placed within the abscess cavity but in spite of this fact no pus outflow was noted. Facing such frustrating and confusing situation the surgeon decided to use US examination of the orbit which showed that the wall of the capsule did not give way to the suction tube, merely bending inside under the pressure of the instrument tip (Fig. 2). It is worth to add that also the whole abscess (visualized on a panel of US device) sprang to and back when pushed with the suction tip. As a matter of fact, the experience from this particular case prompted us to use i-op sonography routinely when dealing with orbital abscess.

Another patient had harbored an irregular, multilocular intraconal abscess which eventually could be drained only sub-totally (Fig. 3A). At first attempt of drainage only sparse amount of pus was evacuated – disproportionally little when compared to abscess volume. While neuronavigation showed correct position of the suction within the abscess cavity, intraoperative sonography was used to demonstrate that only one abscess compartment was emptied at this attempt. Consequently two other compartments were successfully drained under the sonographic control while the last, one adjacent to the optic nerve was left without drainage to avoid a risk of damage to the nerve (Fig. 3B). Proptosis and orbital pressure decreased to almost those of the uninvolved eye after the drainage. The patient was treated with antibiotic and discharged after six days with regained full eye motility and improved visual acuity. Also proptosis and orbital edema resolved almost completely. Subsequent follow-up with orbital sonography revealed gradually diminishing fluid collection laterally to the optic nerve. Four weeks after the discharge total resolution of the abscess and lack of fluid were confirmed on ultrasonographic assessment.

4. Discussion

Our experiences with this clinical series suggest that employment of i-op sonography helps to increase precision of

endoscopic abscess targeting, especially when combined with neuronavigation. In the case of most common medially located SPOAs this added value is less prominent but still it allows reducing fenestration of the orbital wall to a minimum. Such a conservative endoscopic approach has been recommended particularly in children in order to prevent potential postoperative retardation of facial skeleton growth [7,8,10,15]. On the other hand a wide resection of the lamina papyracea is usually recommended during evacuation of medially located SPOAs because incomplete drainage and re-accumulation of puss behind the remnants of this structure is the most common reason for failure of endoscopic surgery [9]. Sonographic check up of drainage helped us to evacuate the pus completely through limited bony perforation so that re-operation was not necessary in any of our patients. On the basis of our experience we can conclude that the utility of intraoperative sonography is higher when dealing with superior and inferior SPOAs because they can have far extending pouches that are difficult to reach by the transnasal approach.

The role of intraoperative sonography becomes much more important when dealing with intraorbital abscesses, as it is illustrated by our two cases mentioned in the result section. The abscess is usually reached by forcing a suction tube through the fat which is to a significant degree a blind maneuver. Lack of puss or its scarce amount when according to neuronavigation the suction tube is expected to reach the abscess cavity puts the surgeon in uncertainty. In this situation intraoperative sonography can show that the abscess has either been bent/swung by the suction tube or only a compartment of the abscess has been reached and drained. Thanks to sonographic upgrading of the guiding with neuronavigation the surgeon can either force the capsule with suction tube or change its direction to target other compartments of the abscess.

The relevant literature suggests another potential employment of intraoperative sonography. Some data indicate that computerized tomography is far from being perfect in discriminating subperiosteal and intraorbital localization of an abscess [8,13]. When intraorbital abscess develops as a result of hematogenous spread of inflammation (and not by extension from adjacent sinuses), the periorbit may look intact when exposed intraoperatively. As a result, further surgery may be abandoned and the abscess inadvertently left inside the orbit. Such cases have already been reported [7,8] but could potentially have been avoided if the intraoperative sonography had been used to help the surgeon gaining confidence and cross the periorbit. It is also worth of remembering that CT imaging not always allows for differential diagnosis between intraorbital inflammatory effusion and matured puss collection. Orbital sonography, though a method of poor general resolution, can reportedly be ahead of CT for imaging of a fluid collection, like encapsulated puss [16–19].

5. Conclusion

Transnasal endoscopy is a method of choice for drainage of medially located subperiosteal and intraorbital abscesses. With intraoperative ultrasonography the surgeon can up-date information from pre-operative CT imaging and neuronavigation. In medial subperiosteal abscesses, sonography helps in more conservative but still effective resection of orbital walls. In the superior and inferior subperiosteal abscesses it helps to reveal remaining non-drained pouches of the abscess. In intraorbital (intraconal) abscesses the method is particularly valuable because it allows for a real-time visualization of tools (suction tube) introduced to the interior of the orbit. Thanks to this feature confusing situation can be made clear, like when abscess only bends/swings under the pressure of an instrument or if only one compartment of the abscess is emptied at first attempt.

Conflict of interest

None declared.

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Ethics

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals.

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