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Detection of abnormally shaped ears by a trained non-specialist allows for early non-surgical intervention

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ABSTRACT

Introduction: Many children are born with abnormally-shaped ears, including protruding ears or unusually-shaped outer ears. While the majority are benign, these may cause significant issues with self-esteem and bullying in childhood. Early molding can resolve some of these abnormalities, avoiding the need for future corrective surgery. However, newborns with these abnormalities are rarely identified early, within the first few days of life, when molding is most effective. In this study, we investigate whether a trained non-specialist can correctly identify ear shape abnormalities in newborns.

Methods: A non-specialist (medical student) was trained on normal and abnormal ear anatomy using photographs and descriptions. Newborns < 72 h of age were recruited from maternity wards. Newborns' ears were photographed and these images were assessed independently by two specialists and the non-specialist. External ear shape was classified as either normal or abnormal based on pre-determined criteria.

Results: A total of 661 ears of 334 newborns were photographed and assessed. High inter-rater agreement was achieved with a kappa statistic of 0.863 (SE 0.078). The non-specialist detected abnormally-shaped ears with a sensitivity and specificity of 90.9% and 91.1% respectively.

Conclusions: Our study illustrates that non-specialist can be trained to accurately detect newborn ear abnormalities, providing a cost-effective means of ensuring that these children's health care needs are met in a timely fashion. Specifically, we recommend the integration of ear shape assessment into currently established programs such as the newborn hearing screening program.

1. Introduction

Many children are born with abnormally-shaped ears, including protruding ears, unusually-shaped outer ears or ears with pits or tags. While the majority of these abnormalities are benign and present only aesthetic concerns, they can cause significant distress for these children and their families later in life, including issues with self-esteem and bullying. Correction of abnormally-shaped ears in children has been associated with improved psychological and social outcomes [1–3]. Following surgical correction of abnormally-shaped ears, children have reported increased happiness, self-confidence, improved social experience, and a reduction or end in bullying. These studies highlight the potential importance of correction in preventing the potentially negative psychological and social effects of ear deformities in children [2].

There is increasing evidence that using simple molding with soft splints or tape in the first few weeks of life may resolve these abnormalities and thereby avoid the need for corrective surgery in an older child. A systematic review of the literature on non-surgical correction of abnormally-shaped ears showed splinting to be a safe and inexpensive technique that yields natural and generally satisfactory results [4]. Several types of ear deformities that are successfully corrected with molding have been described. These include Stahl's ear, prominent ear, and lidding. Stahl's ear is characterized by a third cartilaginous crus extending perpendicular to the helical rim and an abnormal helix (Fig. 1a). Prominent ear, also known as protruding ear, is characterized by an absent anti-helical fold and/or a deep conchal bowl, both of which cause the outer ear to protrude outward from the head (Fig. 1b). Lidding, also known as lop ear, is characterized by a downward fold of the helix (Fig. 1c).

While molding techniques have been shown to be effective in correcting these types of ear shape deformities, many children with these abnormalities are not identified early enough, precluding timely treatment, as examining ear shape is currently not part of the standard newborn screening program in Canada. It has been suggested that ear molding is most effective when initiated within the first three days of life when the cartilage is still soft and malleable [5]. As a result, early

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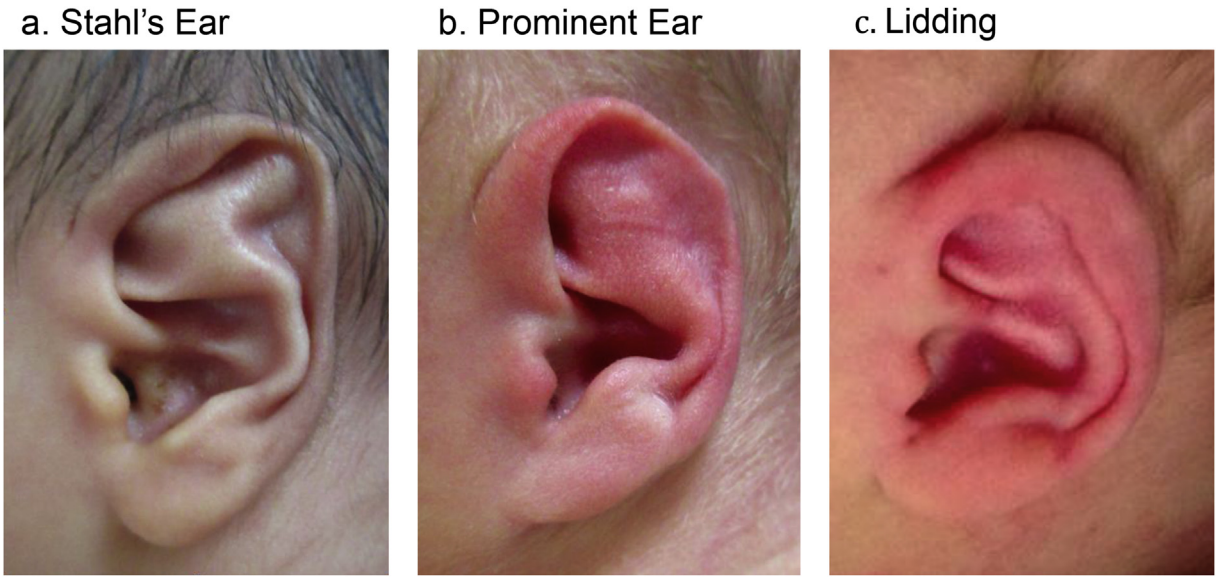

Fig. 1. Examples of abnormally shaped ears assessed in this study.

assessment of newborns to detect abnormally-shaped ears could lead to earlier molding. This may potentially reduce the need for future corrective surgery, improving quality of life for these children.

In 2012, a Mayo Clinic pilot was introduced in which newborn hearing screeners were trained to identify congenital ear deformities [6]. Newborn hearing screens were performed within 24–48 h of birth, thus permitting early detection and immediate correction of these abnormalities with molding, resulting in timely and cost-effective treatment for these children. Our study aimed to advance our understanding of this novel assessment model by assessing the ability of a non-specialist health care professional to accurately identify ear abnormalities in newborns. Demonstrating that a non-specialist can be easily trained to identify these abnormalities would lend support to the integration of ear shape assessment into currently established programs such as the newborn hearing assessment program.

2. Material and methods

Ethical approval for this study was obtained from the University of British Columbia Children's and Women's Research Ethics Board. Fully-informed consent was obtained from each subject prior to data collection.

To assess the accuracy of a non-specialist in the detection of abnormally-shaped ears, the non-specialist, a second year medical student (DYL), was trained for 2 h by a Pediatric Otolaryngologist in the recognition of abnormally-shaped ears with the aid of photographs and descriptions. The non-specialist was provided with information, photographs, and drawings of normal ear anatomy and ear deformities to establish a pre-defined criteria to which all ears would be assessed (Table 1). By this assessment system, abnormal ears were defined as Stahl's ear, prominent ear, pre-auricular pit, ear tag, cupped ear, cryptotia, or microtia. These criteria also encompassed variations of normally-shaped ears defined as lidding, notching, and general ear lobe deformity (Table 1). This assessment system was developed and validated by consensus between two Pediatric Otolaryngologist for accuracy and agreement. As there exists no standardized classification of ear shape deformities, assessment by a Pediatric Otolaryngologist experienced in the recognition and treatment of ear shape abnormalities was considered the “gold standard”. All newborn ears in this study were assessed according to the criteria defined in Table 1.

From June to August 2015, parents of newborns less than 72 h of age were approached for recruitment from the low-risk maternity wards at BC Women's Hospital in Vancouver, British Columbia. Parents of newborns in the Neonatal Intensive Care Unit and newborns with parents or legal guardians who could not speak English were excluded. After parental consent to participate, each child was examined at the first point of contact for any ear shape abnormalities. Both ears of all subjects were photographed unless the parents declined.

These photographs were assessed by the non-specialist and a Pediatric Otolaryngologist noting the presence or absence of ear deformities, according to the aforementioned assessment criteria (Table 1). Initially, the first 130 photographs were reviewed in a blinded fashion in which the non-specialist and Pediatric Otolaryngologist assessed each photograph independently, concealed from each other's classification. The blinded assessments were done to ensure that the non-specialist was appropriately trained. Assessment of the 130 newborns showed high inter-rater agreement consistent with satisfactory assessment of a trained non-specialist. To ensure timely intervention for subjects with ear shape deformities, all following participants were assessed in a non-blinded fashion such that the Pediatric Otolaryngologist reviewed photos while aware of the non-specialist's classification results. The inter-rater agreement between the specialist and non-specialists was calculated using kappa statistic for both the blinded and then the non-blinded photos.

To validate the ratings of the Pediatric Otolaryngology specialist as a gold-standard, assessments of the newborns' ears were compared to those of another Pediatric Otolaryngology specialist. To perform the validation, two hundred photographs of newborn ears were randomly selected and a second Pediatric Otolaryngology specialist reviewed the photos and deemed them as normal or abnormal, and the type of abnormality using the aforementioned predefined criteria. The inter-rater agreement between the specialists was calculated using kappa statistic. Fig. 2 shows a flow diagram of the recruitment and assessment process.

Additional information was collected including newborn's exact age, sex, and ethnicity. Ethnicity was self-identified by the parent and categorized according to the predominant ethnic groups as defined by Statistics Canada. Subjects of multiple ethnic backgrounds were categorized as mixed race and were further subcategorized according to which ethnic groups they self-identified they belonged to by percentage.