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Humanitarian Facial Recognition for Rare Craniofacial Malformations

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Summary: Children with congenital disorders are unfortunate collateral victims of wars and natural disasters. Improved diagnosis could help organize targeted medical support campaigns. Patient identification is a key issue in the management of life-threatening conditions in extreme situations, such as in oncology or for diabetes, and can be challenging when diagnosis requires biological or radiological investigations. Dysmorphology is a central element of diagnosis for craniofacial malformations, with high sensibility and specificity. Massive amounts of public data, including facial pictures circulate daily on news channels and social media, offering unique possibilities for automatic diagnosis based on facial recognition. Furthermore, AI-based algorithms assessing facial features are currently being developed to decrease diagnostic delays. Here, as a case study, we used a facial recognition algorithm trained on a large photographic database to assess an online picture of a family of refugees. Our aim was to evaluate the relevance of using an academic tool on a journalistic picture and discuss its potential application to large-scale screening in humanitarian perspectives. This group picture featured one child with signs of Apert syndrome, a rare condition with risks of severe complications in cases of delayed management. We report the successful automatic screening of Apert syndrome on this low-resolution picture, suggesting that AI-based facial recognition could be used on public data in crisis conditions to localize at-risk patients. *(Plast Reconstr Surg Glob Open 2024; 12:e5780; doi: 10.1097/GOX.0000000000005780; Published online 16 May 2024.)*

CONCISE PRESENTATION OF UNIQUE IDEA, INNOVATION, OR TECHNIQUE

During armed conflicts, life-saving care is prioritized over routine treatments, leading to secondary morbidity and victims, among which children with congenital disorders are specifically vulnerable targets.[1] The situation is considerably more complicated when health structures are intentionally or accidentally destroyed, such as in Gaza since October 2023 or in Ukraine since February 2022. Specific actions for supporting children with rare diseases have been initiated in war zones (such as rarediseaseshub4ua.org for reporting cases requiring specific care) but patient identification based on limited information remains an issue, difficult to tackle especially when large populations are displaced.[2] Massive amounts of visual information are available on the recent armed conflicts, mostly in wide audience media (news channels, social networks), with constant updates and reasonably precise metadata on geographic localization. Many of these public pictures show the faces of victims for journalistic reasons, providing opportunities for diagnosing craniofacial conditions using facial recognition.

On October 15, 2023, the online edition of a major news magazine published the picture (Fig. 1) of a family displaced during a recent conflict to escape bombings. One of the children on the picture exhibited typical features of Apert syndrome, a very rare condition familiar mostly to craniofacial surgeons. This diagnosis hypothesis was supported by the expert opinions from the four attending surgeons of our craniofacial unit, an active department following a large cohort of patients with syndromic craniosynostoses. Apert syndrome is associated with risks of increased intracranial pressure, severe obstructive sleep apnea, cognitive impairment, and loss of vision.[3] This condition requires specialized multidisciplinary management in pediatric centers familiar with rare diseases to prevent severe and definitive functional complications. The child

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in the picture was thus potentially in a situation requiring urgent evaluation and follow-up. The identification of this condition based on this publicly available image could theoretically lead to targeted medical interventions, by reporting the case to the remaining functional health institutions, by analogy with initiatives such as the centralized organization proposed for the management of oncological conditions in Ukraine.[4]

To assess if Apert syndrome could be diagnosed based on this low-resolution picture, we tested an automatic syndrome recognition algorithm designed in our institution, AIDY, currently trained with less than 1000 controls and less than 10,000 pictures of patients with genetically confirmed conditions. AIDY screens frontal, lateral, and external ear pictures. After region of interest detection using a faster region-based convolutional neural network and automatic placement of landmarks using a patch-based active appearance model,[5] AIDY extracts geometric features using Procrustes superimposition, and textural features using a gray-level co-occurrence matrix. Following dimension reduction using principal component analysis and incorporation of metadata, the algorithm uses eXtreme Gradient Boosting, a supervised machine learning classifier.[6,7]

The application of AIDY to this public photograph showed a very high probability for Apert syndrome and very low concordance with controls, based on a specific model taking both facial features and age into account in a cohort of 541 patients with syndromic craniosynostoses.[8] We thus supported the initial hypothesis based on expert opinions (Fig. 1).

DISCUSSION

This case study suggests that automatized disease screening based on facial recognition is a powerful tool in humanitarian conditions. Massive amounts of data, often featuring the face, are available online during wars and crises situations, frequent information on localization. These pictures could be screened with tools such as AIDY to direct medical support towards vulnerable patients requiring specialized care[9] via dedicated emergency structures.[4] The time-consuming screening of massive public data could involve principles derived from data journalism, volunteers, distributed knowledge, and open algorithms following the models of environmental studies and astronomy where the role of amateurs is central.[10] Algorithms such as AIDY are also of major interest in telemedicine, as they allow transfers of competence in dysmorphology, a field of medicine still dependent on expert opinions.[11] Beyond congenital malformations, the automatic quantitative analysis of facial features could be applied to the diagnosis and the follow-up of acquired conditions modifying facial architecture and for the assessment of surgical and/or medical interventions on the craniofacial area.[12]

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Takeaways

Question: Can automatic facial analysis methods be of use in humanitarian medicine?

Findings: This case study suggests that facial recognition algorithms can contribute to localize vulnerable patients in crisis conditions, based on the assessment of publicly available data.

Meaning: The screening of public data using diagnostic algorithms, in the field of congenital disorders and beyond, could be an innovative approach in humanitarian support, to raise awareness on vulnerable populations and target medical campaigns.

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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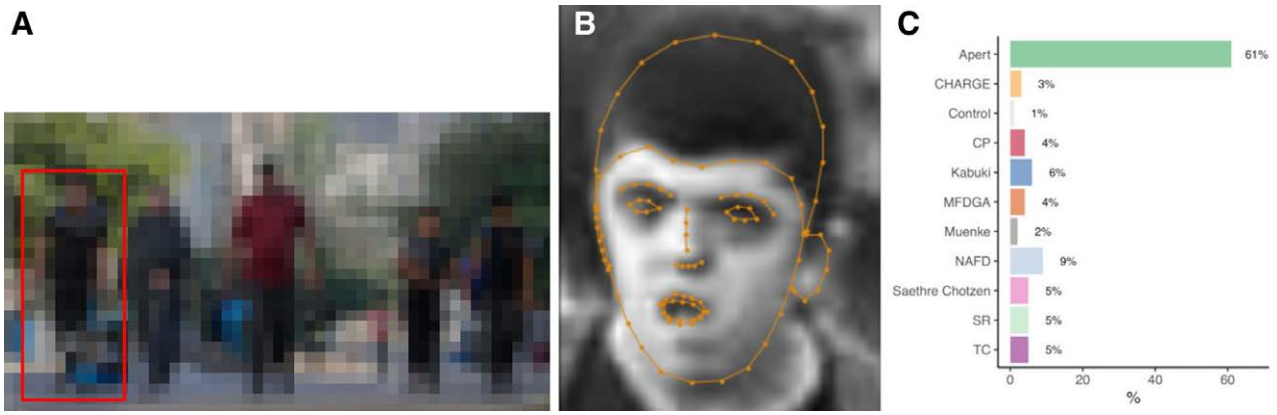

Fig. 1. Evacuation from a conflict zone in October 2023. The boy on the left has a craniofacial malformation, with strong arguments in support of Apert syndrome based on facial analysis, despite the low resolution of the picture. A, Full group picture, blurred for privacy reasons, initially published unblurred. B, Automatic facial landmarking using AIDY tools (methods in Hennocq et al[5]), applied to the non-modified picture, showing the original quality of the image. C, Support for the diagnosis of Apert syndrome vs controls and a significant number of other craniofacial malformations (methods in Hennocq et al[8]). Photography credits for the source picture: Saber Nureldine, European Pressphoto Agency, published online on October 15, 2023. CP, Crouzon-Pfeiffer syndrome; MFDGA, Mandibulo-Facial Dysostosis Guion-Almeida type; NAFD, Nager Acro-Facial Dysostosis; SR, Russel-Silver syndrome; TC, Treacher Collins syndrome.