

## Plastic surgery in the metaverse: challenges and opportunities

Most buzzwords are short-lived, but one that refuses to disappear is the “metaverse”. Although there isn't a closed definition, the metaverse is deemed to be its own digital reality; a virtual dimension, in which users can share interactions and experiences by utilizing their own personalized online avatar. The metaverse integrates a spectrum of futuristic technologies, including virtual reality (VR), augmented reality (AR), artificial intelligence (AI), mixed reality and blockchain<sup>1</sup> which are all planned to amalgamate into one digitized world<sup>2</sup>.

As plastic surgeons of the future, we should embrace this technological revolution, and, as neurosurgeon Dr Robert Masson (who we will meet later) described it, “foundationally prepare for what's coming.”<sup>3</sup>

Sometimes it seems that the entire internet is rife with discussion about the potential applications of the metaverse and its impact on our lives, but there is little data on how plastic, reconstructive and aesthetic surgery may utilize it.<sup>4</sup>

Despite the metaverse seeming like a futuristic concept that is still far from operational, the metaverse is up and running (albeit in its preliminary stages) and has already penetrated the world of plastic surgery. Therefore, we will explore present-day uses, as well as future challenges and opportunities.

In May 2022, the world's first oncoplastic surgery was performed using the metaverse. Dr Pedro Gouveia completed a breast-cancer removal under the guidance of Dr. Rogelio Andres-Luna, who was 900km away from the theatre. Dr Gouveia wore Microsoft HoloLens 2 mixed reality goggles, allowing Dr Andres-Luna to be present in the theatre despite physically being in a remote location<sup>5</sup>. Plastic surgeons can therefore leverage the metaverse to provide their specialized expertise in surgeries conducted remotely and beyond their physical reach. This would increase surgical efficiency and relieve plastic surgeons from the constraints of location.

At present, the main use of the metaverse within the surgical world is for skill training<sup>6</sup>. In May 2021, a hospital in Bundang, Korea used the metaverse to train 200 thoracic Surgeons located all over Asia, in a live conference. Participants wore head-mounted display (HMD) to access an extended reality platform, through which they observed lung cancer surgery techniques and watched lectures<sup>7</sup>. This offers a glimpse of how the metaverse could be used to train future plastic surgeons.

In addition to live training, plastic surgeons can utilize the metaverse to independently refine surgical techniques on their own accord. Touch surgery™ is a free mobile application that contains a database of tutorials to teach surgical procedures<sup>8</sup>. The platform is currently working on integrating mixed reality capabilities with Microsoft HoloLens, which would allow plastic surgeons to practice procedures using gesture-based interactions in a more immersive manner, all through the comfort of their own phone. However, there are barriers to this. The technology to replicate the physical sensations felt during surgery (such as holding a scalpel) in the metaverse, is still under research. This is “haptic feedback” and is a separate field of study.<sup>2</sup>

An organization leading the charge in the surgical metaverse is dedicated to improving the operating theater, as opposed to the surgery itself. For centuries, surgical facilities have relied on the same technology. However, Dr. Robert Masson's startup, Expanded Existence™, is developing an augmented reality medical system that could significantly enhance the efficiency and workflow of surgical procedures. This technology may potentially eliminate the need for preference cards during surgery.<sup>9</sup>

Imagine being able to generate an ultra-realistic 3D rendering of your body by only taking a few photos, and personally modifying that virtual representation to create your dream appearance, as if you were designing a

video game character. Two technologies, both pioneers of the surgical metaverse, have managed to achieve just that.

Crisalix<sup>10</sup> is a mixed reality (combining both AR and VR) software that holds great promise in aiding plastic surgery patients with decision-making regarding surgery. Created as an extension of the iPad, the device takes multiple pictures of the user, and translates this digital information into a 3D avatar within the Crisalix software. The user can then manipulate the rendition using augmented reality to match their aesthetic preference. This allows the user to look into a magic mirror and foresee their exact post-operative appearance before they have even entered the theatre<sup>4</sup>. Arbrea labs created a similar software, offering plastic surgery simulation tools for the breasts and face.<sup>11</sup>

This may seem impressive on paper, but does it demonstrate effectiveness in practical application? One medical study demonstrated that the Crisalix 3D-imaging system (combined with the use of physical calipers) is the most effective method of estimating the volume of breast implants for breast augmentation surgery, to produce a very high rate of patient satisfaction (100% of the 40 women were satisfied with their post-operative results)<sup>12</sup>. Another study, evaluating the accuracy of Crisalix in predicting postoperative breast implant volume, reported that 93% of patients believed that Crisalix aided them in choosing their prosthesis, and only 3% estimated that Crisalix was not necessary for the pre-operative process. The study concluded that the most effective approach for determining breast implant volume involves using a combination of advanced 3D-imaging technology and trying out different implant sizes in a bra, which is a traditional method<sup>13</sup>. Although augmented reality technology has demonstrated significant potential in plastic surgery, it is not yet advanced enough to entirely replace conventional techniques.

Nevertheless, this technology has a multitude of implications for the future of plastic surgery, including the ability for plastic surgeons to create virtual operating rooms in the metaverse and interact with patients through personal avatars<sup>6</sup>. As previously mentioned, patients may benefit by visually representing and describing their surgical goals in the metaverse. Multidisciplinary team meetings may be more efficient, with doctors having the ability to meet and describe care plans in one virtual space without the need for physical presence. It also enables plastic surgeons to attend academic conferences without being limited by time and space and allows them to provide immersive training to trainee surgeons in remote locations.<sup>14</sup>

Huge strides have been made in the technological advancements of plastic surgery, but the integration of the worlds of plastic surgery and the metaverse is still in its infancy. Further developments are needed to fully amalgamate the two fields. The most crucial point is that present technology does not simulate the potentially severe emergencies that may arise during plastic surgery, such as facial nerve damage during a face lift, or pneumothorax during a breast augmentation or liposuction. Whilst it is good for a surgical trainee to practice procedures within the comfort of their own home via the metaverse, it may create a deceptive sense of confidence because it lacks the real-life gravity and consequences of surgical emergencies.<sup>2</sup>

Moreover, VR headsets can be uncomfortable and obstructive to wear, and extended use may even induce nausea or vertigo, which restricts their effectiveness for surgical training, and certainly as a tool used during the surgery itself<sup>2</sup>.

Regarding the 3D simulation software discussed earlier, although this may seem extremely beneficial for plastic surgery, what is not discussed is how widespread access to such advanced software may impact society as a whole.

There is no denying that looks matter more than they ever have before. Social media runs rampant in today's modern society, creating a toxic culture of comparison<sup>15</sup>. Research shows that physically attractive people

tend to have increased self-esteem because of preferential treatment received during childhood (positive reinforcement theory)<sup>16</sup> and are more likely to encounter advantageous circumstances in their personal and professional lives, such as with dating<sup>17</sup> and employment<sup>18</sup>. As a result, people are willing to go to increasingly extreme lengths to achieve an idealized version of aesthetic appearance.

Softwares such as Crisalix<sup>10</sup> and Arbrea labs<sup>11</sup> may be opening Pandora's box in some sense, as they make these "extreme lengths" very easily accessible to the public. People will be able to easily create highly detailed and customizable 3D renderings of their ideal appearance, all through an app on their phone.

As a result, the rapid inflation of beauty standards may occur. This will inevitably lead to an increase in body dysmorphia, the further objectification of people based on their appearance, increased discrimination and overall negative attitudes towards those whose appearances do not conform to what society deems as ideal.

The reality is that society's growing emphasis on physical appearance and the prevalence of body dysmorphia will undoubtedly lead to a higher demand for plastic surgery. On a somewhat dark note, plastic surgeons could potentially capitalize on this shift and reap financial and business benefits.

To conclude, although it has the potential to revolutionize the field of plastic surgery in ways that are unimaginable, the metaverse is still in development, and the practical effect of the metaverse on plastic surgery is yet to be observed<sup>6</sup>. Nevertheless, plastic surgeons should be ready to adapt, embrace and utilize the inevitable changes that will occur to plastic surgery in the near future.<sup>14</sup>

Word count: 1465

## References

- 1- Bhugaonkar K, Bhugaonkar R, Masne N. The trend of Metaverse and augmented & virtual reality extending to the healthcare system. Cureus [Internet]. 2022 [cited 2023 Mar 24];14(9):e29071. Available from: <https://www.cureus.com/articles/106227-the-trend-of-metaverse-and-augmented--virtual-reality-extending-to-the-healthcare-system#!/>
- 2- Lee GK, Moshrefi S, Fuertes V, Veeravagu L, Nazerali R, Lin SJ. What is your reality? Virtual, augmented, and mixed reality in plastic surgery training, education, and practice. *Plast Reconstr Surg* [Internet]. 2021 [cited 2023 Mar 24];147(2):505–11. Available from: [https://journals.lww.com/plasreconsurg/Fulltext/2021/02000/What\\_Is\\_Your\\_Reality\\_\\_Virtual,\\_Augmented,\\_and.39.aspx?casa\\_token=BAoYtIbSpzAAAAAA:j9YR1tNjjOnlx9c-ltOUyVgayXK71FcUjltMy263mzVeava0xuK2jvDXGfJ80nDyvZbnYveE56PljGem1B8x\\_apYDAfbADw](https://journals.lww.com/plasreconsurg/Fulltext/2021/02000/What_Is_Your_Reality__Virtual,_Augmented,_and.39.aspx?casa_token=BAoYtIbSpzAAAAAA:j9YR1tNjjOnlx9c-ltOUyVgayXK71FcUjltMy263mzVeava0xuK2jvDXGfJ80nDyvZbnYveE56PljGem1B8x_apYDAfbADw)
- 3- eXeX™. The eXeX(TM) solution: Enhancing the medical field through augmented reality, paving the way to revolutionize the operating room [Internet]. Yahoo Finance. 2022 [cited 2023 Mar 24]. Available from: [https://finance.yahoo.com/news/exex-tm-solution-enhancing-medical-170500816.html?guccounter=2&guce\\_referrer=aHR0cHM6Ly90LmNvLWw&guce\\_referrer\\_sig=AQAAADj4Tc5UAIPhfsOj5P4sUCQ4YQQFigK9zMTt4vfJJAgY2Sywd3pYkViPdXO2z0QwTuN7OiKWUITsneBgi1lKWCrpielXMFal1zpGKWgoAt0pbu\\_BrgXD\\_RXSunbUaEYS3SCqQldIO2AyhBVwOafPEF1aX74AOHAh5eZPArSxZrTq](https://finance.yahoo.com/news/exex-tm-solution-enhancing-medical-170500816.html?guccounter=2&guce_referrer=aHR0cHM6Ly90LmNvLWw&guce_referrer_sig=AQAAADj4Tc5UAIPhfsOj5P4sUCQ4YQQFigK9zMTt4vfJJAgY2Sywd3pYkViPdXO2z0QwTuN7OiKWUITsneBgi1lKWCrpielXMFal1zpGKWgoAt0pbu_BrgXD_RXSunbUaEYS3SCqQldIO2AyhBVwOafPEF1aX74AOHAh5eZPArSxZrTq)
- 4- The Metaverse as a new approach to aesthetic consultations [Internet]. Crisalix. [cited 2023 Mar 24]. Available from: <https://www.crisalix.com/en/news/the-metaverse-as-a-new-approach-to-aesthetic-consultations>

- 5- Rajpalsinh. Surgeon performed surgery remotely through Metaverse [Internet]. The Crypto Times - Latest and Crisp Cryptocurrency news. 2022 [cited 2023 Mar 24]. Available from: <https://www.cryptotimes.io/surgeon-performed-surgery-remotely-through-metaverse/>
- 6- Sun P, Zhao S, Yang Y, Liu C, Pan B. How do Plastic Surgeons use the Metaverse: A Systematic Review. *J Craniofac Surg* [Internet]. 2023 [cited 2023 Mar 24];34(2):548–50. Available from: [https://journals.lww.com/jcraniofacialsurgery/Fulltext/2023/03000/How\\_do\\_Plastic\\_Surgeons\\_use\\_the\\_Metaverse\\_\\_A.25.aspx](https://journals.lww.com/jcraniofacialsurgery/Fulltext/2023/03000/How_do_Plastic_Surgeons_use_the_Metaverse__A.25.aspx)
- 7- Koo H. Training in lung cancer surgery through the metaverse, including extended reality, in the smart operating room of Seoul National University Bundang Hospital, Korea. *J Educ Eval Health Prof* [Internet]. 2021 [cited 2023 Mar 24];18:33. Available from: <http://dx.doi.org/10.3352/jeehp.2021.18.33>
- 8- Mandler AG. Touch Surgery: A twenty-first century platform for surgical training. *J Digit Imaging* [Internet]. 2018;31(5):585–90. Available from: <http://dx.doi.org/10.1007/s10278-018-0102-y>
- 9- Kemmerer F, 'Thiagi' Thiagarajan S. EXEX: An experiential activity on experimental research. *Simul Gaming* [Internet]. 1993 [cited 2023 Mar 24];24(1):116–9. Available from: <https://www.expandedexistence.com/>
- 10- CRISALIX: Simulate your new body in 3D with your photos [Internet]. Crisalix. [cited 2023 Mar 24]. Available from: <https://www.crisalix.com/en>
- 11- Labs A. Arbrea pioneers the Medical Metaverse [Internet]. Arbrea Labs. 2022 [cited 2023 Mar 24]. Available from: <https://arbrea-labs.com/arbrea-pioneers-the-medical-metaverse/>
- 12- Hammond DC, Kim K, Bageris MH, Chaudhry A. Use of three-dimensional imaging to assess the effectiveness of volume as a critical variable in breast implant selection. *Plast Reconstr Surg* [Internet]. 2022 [cited 2023 Mar 24];149(1):70–9. Available from: [https://journals.lww.com/plasreconsurg/Abstract/2022/01000/Use\\_of\\_Three\\_Dimensional\\_Imaging\\_to\\_Assess\\_the.11.aspx](https://journals.lww.com/plasreconsurg/Abstract/2022/01000/Use_of_Three_Dimensional_Imaging_to_Assess_the.11.aspx)
- 13- de Runz A, Boccara D, Bertheuil N, Claudot F, Brix M, Simon E. Three-dimensional imaging, an important factor of decision in breast augmentation. *Ann Chir Plast Esthet* [Internet]. 2018 [cited 2023 Mar 24];63(2):134–9. Available from: <https://pubmed.ncbi.nlm.nih.gov/28911890/>
- 14- Elmer NA, Hassell N, Comer CD, Bustos V, Lin SJ. Plastic surgery in the metaverse. *Plast Surg (Oakv)* [Internet]. 2022;229255032211097. Available from: <http://dx.doi.org/10.1177/22925503221109714>
- 15- Vogel EA, Rose JP, Roberts LR, Eckles K. Social comparison, social media, and self-esteem. *Psychol Pop Media Cult* [Internet]. 2014;3(4):206–22. Available from: <http://dx.doi.org/10.1037/ppm0000047>
- 16- Mares SHW, de Leeuw RNH, Scholte RHJ, Engels RCME. Facial attractiveness and self-esteem in adolescence. *J Clin Child Adolesc Psychol* [Internet]. 2010;39(5):627–37. Available from: <http://dx.doi.org/10.1080/15374416.2010.501292>

17- Stahlschmidt ZR, Chu I, Koh C. When do looks matter? Effects of mate quality and environmental variability on lifetime reproduction. *Behav Ecol Sociobiol* [Internet]. 2020;74(1). Available from: <http://dx.doi.org/10.1007/s00265-019-2790-9>

18- Chiang CI, Saw YL. Do good looks matter when applying for jobs in the hospitality industry? *Int J Hosp Manag* [Internet]. 2018;71:33–40. Available from: <https://www.sciencedirect.com/science/article/pii/S0278431916301475>