FIVE MEDICAL DEVICES

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January 28, 2022

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1 3D SURFACE IMAGING

Three-dimensional (3D) surface imaging system has gained popularity worldwide in clinical application. Unlike computed tomography and magnetic resonance imaging, it has the ability to capture 3D images with both shape and texture information. This feature has made it quite useful for plastic surgeons. This review article is mainly focusing on demonstrating the current status and analyzing the future of the application of 3D surface imaging systems in plastic and reconstructive surgery.Currently, 3D surface imaging system is mainly used in plastic and reconstructive surgery to help improve the reliability of surgical planning and assessing surgical outcome objectively. There have already been reports of its using on plastic and reconstructive surgery from head to toe. Studies on facial aging process, online applications development, and so on, have also been done through the use of 3D surface imaging system.Because different types of 3D surface imaging devices have their own advantages and disadvantages, a basic knowledge of their features is required and careful thought should be taken to choose the one that best fits a surgeon's demand.In the future, by integrating with other imaging tools and the 3D printing technology, 3D surface imaging system will play an important role in individualized surgical planning, implants production, meticulous surgical simulation, operative techniques training, and patient education.

1.1 3D imaging in plastic surgery

Three-dimensional surface imaging has gained clinical acceptance in plastic and reconstructive surgery. In contrast to computed tomography/magnetic resonance imaging, three-dimensional surface imaging relies on triangulation in stereophotography to measure surface x, y, and z coordinates. This study reviews the past, present, and future directions of three-dimensional topographic imaging in plastic surgery. Historically, three-dimensional imaging technology was first used in a clinical setting in 1944 to diagnose orthodontologic conditions. Karlan established its use in the field of plastic surgery in 1979, analyzing contours and documenting facial asymmetries. Present use of three-dimensional surface imaging has focused on standardizing patient topographic measurements to enhance preoperative planning and to improve postoperative outcomes. Various measurements (e.g., volume, surface area, vector distance, curvature) have been applied to breast, body, and facial topography to augment patient analysis. Despite the rapid progression of the clinical applications of three-dimensional imaging, current use of this technology is focused on the surgeon's perspective and secondarily the patient's perspective. Advancements in patient simulation may improve patient-physician communication, education, and satisfaction. However, a communal database of three-dimensional surface images integrated with emerging three-dimensional printing and portable information technology will validate measurements and strengthen preoperative planning and postoperative outcomes. Three-dimensional surface imaging is a useful adjunct to plastic and reconstructive surgery practices and standardizes measurements to create objectivity in a subjective field. Key improvements in three-dimensional imaging technology may significantly enhance the quality of plastic and reconstructive surgery in the near future.

2 Air-Purifying Respirator

A powered air-purifying respirator (PAPR) is a type of respirator used to safeguard workers against contaminated air. PAPRs consist of a headgear-and-fan assembly that takes ambient air contaminated with one or more type of pollutant or pathogen, actively removes (filters) a sufficient proportion of these hazards, and then delivers the clean air to the user's face or mouth and nose. They have a higher assigned protection factor than filtering facepiece respirators such as N95 masks. PAPRs are sometimes called positive-pressure masks, blower units, or just blowers.PAPRs may be outfitted with mechanical filters for atmospheres with particulate contamination, with a chemical cartridge for atmospheres with toxic gases or vapors, or both in combination. PAPRs can provide an assigned protection factor between 25 and 1000 depending on the type, as compared to an N95 mask's assigned protection factor of Loose-fitting PAPRs typically have an APF of 25, and PAPRs with elastomeric masks that seal to the face (similar to those in elastomeric respirator masks) have an APF of 1000. When comparing various makes and models of PAPR, the supporting documentation from each of the respective manufacturers should be consulted in order to confirm the APF value of each product.

2.1 Usage

According to the NIOSH Respirator Selection Logic, PAPRs are recommended for concentrations of hazardous particulates or gases that are greater than the relevant occupational exposure limit but less than the immediately dangerous to life or health (IDLH) level and the manufacturer's maximum-use concentration, subject to the respirator having a sufficient assigned protection factor. For substances hazardous to the eyes, a respirator equipped with a full facepiece, helmet, or hood is recommended. PAPRs are not effective during firefighting, in an oxygen-deficient atmosphere, or in an unknown atmosphere; in these situations a self-contained breathing apparatus or supplied-air respirator is recommended instead.

PAPRs have the advantage of eliminating breathing resistance caused by unpowered negative-pressure respirators such as N95 masks. This makes them usable by persons who are medically disqualified from negative-pressure respirators. Loose-fitting PAPRs may also be selected for people who cannot pass a fit test due to facial hair or other reasons. PAPRs have disadvantages in terms of ergonomic impacts, and they restrict peripheral vision. Becausese they provide higher assigned protection factors, PAPRs are suitable for use during aerosol-generating procedures and by hospital first receivers. In healthcare settings, CDC recommends cleaning of all components except the filter after each use; care must be taken to select PAPRs that are not damaged or deteriorate due to cleaning and disinfecting agents. Some PAPRs have special certification for chemical, biological, radiological, and nuclear contaminants (CBRN). In the United States, they must be certified to resist permeation of chemical warfare agents, which may involve additional protective coverings; that gas or vapor will not pass through the filter before a specified amount of time; and its ability to fit a wide range of facial sizes and shapes.

Under immediately dangerous to life or health (IDLH) conditions, tight-fitting full facepiece gas mask respirators with canisters (those with "14G approval") with CBRN approval may be used for escape, but loose-fitting hoods and cartridges with CBRN approval may not. Neither may be used to enter an IDLH atmosphere. The 23C CBRN PAPRs also must not be used if liquid droplet exposure occurs.

3 Ambulance

An ambulance is a medically equipped vehicle which transports patients to treatment facilities, such as hospitals.Typically, out-of-hospital medical care is provided to the patient.Ambulances are used to respond to medical emergencies by emergency medical services. For this purpose, they are generally equipped with flashing warning lights and sirens. They can rapidly transport paramedics and other first responders to the scene, carry equipment for administering emergency care and transport patients to hospital or other definitive care. Most ambulances use a design based on vans or pickup trucks. Others take the form of motorcycles, buses, limousines, aircraft and boats.Vehicles count as an ambulance if they can transport patients. However, it varies by jurisdiction as to whether a non-emergency patient transport vehicle is counted as an ambulance. These vehicles are not usually (although there are exceptions) equipped with life-support equipment, and are usually crewed by staff with fewer qualifications than the crew of emergency ambulances. Conversely, EMS agencies may also have emergency response vehicles that cannot transport patients.These are known by names such as nontransporting EMS vehicles, fly-cars or response vehicles.The term ambulance comes from the Latin word ambulare as meaning to walk or move about which is a reference to early medical care where patients were moved by lifting or wheeling. The word originally meant a moving hospital, which follows an army in its movements.Ambulances were first used for emergency transport in 1487 by the Spanish forces during the siege of Málaga by the Catholic Monarchs against the Emirate of Granada. During the American Civil War vehicles for conveying the wounded off the field of battle.

3.1 Design and construction

Ambulance design must take into account local conditions and infrastructure. Maintained roads are necessary for road-going ambulances to arrive on scene and then transport the patient to a hospital, though in rugged areas four-wheel drive.Fuel must be available and service facilities are necessary to maintain the vehicle.Methods of summoning (e.g. telephone) and dispatching ambulances usually rely on electronic equipment, which itself often relies on an intact power grid. Similarly, modern ambulances are equipped with two-way radios[33] or cellular telephones to enable them to contact hospitals, either to notify the appropriate hospital of the ambulance's pending arrival, or, in cases where physicians do not form part of the ambulance's crew, to confer with a physician for medical oversight.

Ambulances often have two stages of manufacturing. The first is frequently the manufacture of light or medium truck chassis-cabs or full-size vans (or in some places, cars) such as Mercedes-Benz, Nissan, Toyota, or Ford. The second manufacturer (known as second stage manufacturer) modifies the vehicle (which is sometimes purchased incomplete, having no body or interior behind the driver's seat) and turns it into an ambulance by adding bodywork, emergency vehicle equipment, and interior fittings. This is done by one of two methods – either coachbuilding, where the modifications are started from scratch and built on to the vehicle, or using a modular system, where a pre-built 'box' is put on to the empty chassis of the ambulance, and then finished off.Modern ambulances are typically powered by internal combustion engines, which can be powered by any conventional fuel, including diesel, gasoline or liquefied petroleum gas depending on the preference of the operator and the availability of different options. Colder regions often use gasoline-powered engines, as diesels can be difficult to start when they are cold. Warmer regions may favor diesel engines, as they are more efficient and more durable. Diesel power is sometimes chosen due to safety concerns, after a series of fires involving gasoline-powered ambulances during the 1980s. These fires were ultimately attributed in part to gasoline's higher volatility in comparison to diesel fuel.The type of engine may be determined by the manufacturer: in the past two decades, Ford would only sell vehicles for ambulance conversion if they are diesel-powered. Beginning in 2010, Ford will sell its ambulance chassis with a gasoline engine in order to meet emissions requirements.

3.2 Reuse of retired ambulances

When an ambulance is retired, it may be donated or sold to another EMS provider. Alternately, it may be adapted into a storage and transport vehicle for crime scene identification equipment, a command post at community events, or support vehicle, such as a logistics unit. Others are refurbished and resold or may just have their emergency equipment removed to be sold to private businesses or individuals, who then can use them as small recreational vehicles. They may also have a perfectly serviceable body or vehicle (or both) separated from the other and reused. Toronto City Council has begun a "Caravan of Hope" project to provide retired Toronto ambulances a second life by donating them to the people of El Salvador. Since laws in Ontario require ambulances to be retired after just four and a half years in service, the City of Toronto decommissions and auctions 28 ambulances each year.

4 Artificial Heart Valve

An artificial heart valve is a one-way valve implanted into a person's heart to replace a heart valve that is not functioning properly . Artificial heart valves can be separated into three broad classes: mechanical heart valves, bioprosthetic tissue valves and engineered tissue valves.The human heart contains four valves: tricuspid valve, pulmonary valve, mitral valve and aortic valve. Their main purpose is to keep blood flowing in the proper direction through the heart, and from the heart into the major blood vessels connected to it . Heart valves can malfunction for a variety of reasons, which can impede the flow of blood through the valve and or let blood flow backwards through the valve. Both processes put strain on the heart and may lead to serious problems, including heart failure. While some dysfunctional valves can be treated with drugs or repaired, others need to be replaced with an artificial valve.

4.1 Tissue-engineered valves

For over 30 years researchers have been trying to grow heart valves in vitro.These tissue-engineered valves involve seeding human cells on to a scaffold. The two main types of scaffold are natural scaffolds, such as decellularized tissue, or scaffolds made from degradable polymers. The scaffold acts as an extracellular matrix, guiding tissue growth into the correct 3D structure of the heart valve.Some tissue-engineered heart valves have been tested in clinical trials, but none are commercially available.Tissue engineered heart valves can be person-specific and 3D modeled to fit an individual recipient[3D printing is used because of its high accuracy and precision of dealing with different biomaterials.Cells that are used for tissue engineered heart valves are expected to secrete the extracellular matrix . Extracellular matrix provides support to maintain the shape of the valves and determines the cell activities.Scientists can follow the structure of heart valves to produce something that looks similar to them, but since tissue engineered valves lack the natural cellular basis, they either fail to perform their functions like natural heart valves, or function when they are implanted but gradually degrade over time. An ideal tissue engineered heart valve would be non-thrombogenic, biocompatible, durable, resistant to calcification, grow with the surrounding heart, and exhibit a physiological hemodynamic profile. To achieve these goals, the scaffold should be carefully chosen—there are three main candidates: decellularized ECM ,natural polymers, and synthetic polymers

4.2 Differences between mechanical and tissue valves

Mechanical and tissue valves are made of different materials. Mechanical valves are generally made of titanium and carbon. Tissue valves are made up of human or animal tissue. The valves composed of human tissue, known as allografts are from donors' human hearts.Mechanical valves can be a better choice for younger people and people at risk of valve deterioration due to its durability. It is also preferable for people who are already taking blood thinners and people who would be unlikely to tolerate another valve replacement operation.Tissue valves are better for older age groups as another valve replacement operation may not be needed in their lifetime. Due to the risk of forming blood clots for mechanical valves and severe bleeding as a major side effect of taking blood-thinning medications, people who have a risk of blood bleeding and are not willing to take warfarin may also consider tissue valves. Other patients who may be more suitable for tissue valves are people who have other planned surgeries and unable to take blood-thinning medications. People who plan to become pregnant may also consider tissue valves as warfarin causes risks in pregnancy.

4.3 Artificial heart valve repair

Artificial heart valves are expected to last from 10 to 30 years.The most common problems with artificial heart valves are various forms of degeneration, including gross billowing of leaflets, ischemic mitral valve pathology, and minor chordal lengthening.The repairing process of the artificial heart valve regurgitation and stenosis usually requires an open-heart surgery, and a repair or partial replacement of regurgitant valves is usually preferred.Researchers are investigating catheter-based surgery that allows repair of an artificial heart valve without large incisions.

5 CT Scanner

A computerized tomography scan combines a series of X-ray images taken from different angles around your body and uses computer processing to create cross-sectional images of the bones, blood vessels and soft tissues inside your body. CT scan images provide more-detailed information than plain X-rays do.A CT scan or computed tomography scan is a medical imaging technique used in radiology to obtain detailed internal images of the body for diagnostic purposes. The personnel that perform CT scans are called radiographers or radiology technologists.CT scanners use a rotating X-ray tube and a row of detectors placed in the gantry to measure X-ray attenuations by different tissues inside the body. The multiple X-ray measurements taken from different angles are then processed on a computer using reconstruction algorithms to produce tomographic images of a body. The use of ionizing radiation sometimes restricts its use owing to its adverse effects. However, CT can be used in patients with metallic implants or pacemakers where MRI is contraindicated. CT has proven to be a versatile imaging technique. While CT is most prominently used in diagnostic medicine, it also may be used to form images of non-living objects.

5.1 perfusion imaging

CT perfusion imaging is a specific form of CT to assess flow through blood vessels whilst injecting a contrast agent.Blood flow, blood transit time, and organ blood volume, can all be calculated with reasonable sensitivity and specificity.This type may be used on the heart, although sensitivity and specificity for detecting abnormalities are still lower than for other forms of CT.This may also be used on the brain, where CT perfusion imaging can often detect poor brain perfusion well before it is detected using a conventional spiral CT scan.This is better for stroke diagnosis than other CT types.

5.2 Medical use

CT has become an important tool in medical imaging to supplement X-rays. It has more recently been used for preventive medicine or screening for disease, for example, CT colonography for people with a high risk of colon cancer, or full-motion heart scans for people with a high risk of heart disease. Several institutions offer full-body scans for the general population although this practice goes against the advice and official position of many professional organizations in the field primarily due to the radiation dose applied. The use of CT scans has increased dramatically over the last two decades in many countries.An estimated 72 million scans were performed in the United States in 2007 and more than 80 million in 2015.CT scanning of the head is typically used to detect infarction , tumors, calcifications, haemorrhage, and bone trauma.Of the above, dark structures can indicate edema and infarction,brigh structures indicate calcifications and haemorrhage and bone trauma can be seen as disjunction in bone windows. Tumors can be detected by the swelling and anatomical distortion they cause, or by surrounding edema. CT scanning of the head is also used in CT-guided stereotactic surgery and radiosurgery for treatment of intracranial tumors, arteriovenous malformations, and other surgically treatable conditions using a device known as the N-localizer.

A CT scan can be used for detecting both acute and chronic changes in the lung parenchyma, the tissue of the lungs. It is particularly relevant here because normal two-dimensional X-rays do not show such defects. A variety of techniques are used, depending on the suspected abnormality. For evaluation of chronic interstitial processes such as emphysema, and fibrosis, thin sections with high spatial frequency reconstructions are used; often scans are performed both on inspiration and expiration. This special technique is called high resolution CT that produces a sampling of the lung, and not continuous images.An incidentally found nodule in the absence of symptoms (sometimes referred to as an incidentaloma) may raise concerns that it might represent a tumor, either benign or malignant.Perhaps persuaded by fear, patients and doctors sometimes agree to an intensive schedule of CT scans, sometimes up to every three months and beyond the recommended guidelines, in an attempt to do surveillance on the nodules. However, established guidelines advise that patients without a prior history of cancer and whose solid nodules have not grown over a two-year period are unlikely to have any malignant cancer. For this reason, and because no research provides supporting evidence that intensive surveillance gives better outcomes, and because of risks associated with having CT scans, patients should not receive CT screening in excess of those recommended by established guidelines.

5.3 Advantages

CT scanning has several advantages over traditional two-dimensional medical radiography. First, CT eliminates the superimposition of images of structures outside the area of interest.CT scans have greater image resolution, enabling examination of finer details. The improved resolution of CT has permitted the development of new investigations. For example, CT angiography avoids the invasive insertion of a catheter. CT scanning can perform a virtual colonoscopy with greater accuracy and less discomfort for the patient than a traditional colonoscopy. Virtual colonography is far more accurate than a barium enema for detection of tumors and uses a lower radiation dose.CT is a moderate- to high-radiation diagnostic technique. The radiation dose for a particular examination depends on multiple factors: volume scanned, patient build, number and type of scan sequences, and desired resolution and image quality. Two helical CT scanning parameters, tube current and pitch, can be adjusted easily and have a profound effect on radiation. CT scanning is more accurate than two-dimensional radiographs in evaluating anterior interbody fusion, although they may still over-read the extent of fusion.

5.4 Disadvantages

The radiation used in CT scans can damage body cells, including DNA molecules, which can lead to radiation-induced cancer. The radiation doses received from CT scans is variable. Compared to the lowest dose x-ray techniques, CT scans can have 100 to 1,000 times higher dose than conventional X-rays.lumbar spine x-ray has a similar dose as a head CT. Articles in the media often exaggerate the relative dose of CT by comparing the lowest-dose x-ray techniques with the highest-dose CT techniques. In general, the radiation dose associated with a routine abdominal CT has a radiation dose similar to three years of average background radiation.