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REVIEW ARTICLE

Left handedness in cardiac surgery—boon or bane?

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Abstract
Left-handed individuals consist of around 11% of the population and true ambidextrous consists of only 2–3% of the total population. Almost a similar ratio is seen in medical profession also. Difficulties are obvious for left-handed cardiac surgeons in the operating room due to regular right-handed instruments, laterality, and positioning of the patients. In this article, we discuss about the problems and the potential solutions for left-handed cardiac surgeons.

Keywords Left handedness · Left-handed cardiac surgeons · Left-handed surgical instruments

Background

A vast majority of the people in the world are right handed and these demographics are extrapolated to every country and every profession. Though the percentage may vary from 80 to 90%, there is no country or civilization in the world where these demographics are reversed and right handedness is a minority. Left handedness on the other hand consists around 11% of the population with true ambidextrous people consisting just 2–3% of the population. Almost the same ratio is seen in medical profession. Difficulties are more obvious for a surgeon in the operating room where the right-handed instruments and the laterality and positioning of the patient become issues and it is never straightforward. In this narrative review, we will be discussing basic concepts of left handedness and tips and tricks related to general operating protocol in a cardiac operation theatre and adult cardiac surgery.

The problem

The first step in solving any problem is realizing and accepting that the problem exists. There has been historical disadvantage to this uneven split of the handedness in the population. Starting from the very beginning in life, at the school age, a left-handed person comes across problems in routine equipment and its activities like scissors, desks, notebooks, peeling knife, zipper of trouser, waist belt, wrist watch belt, and the list is endless. These small things eventually train a left-handed person to get adapted to the instruments of the opposite laterality.

Even in the medical community, the past for left-handed people has not been always this glorious. In a 1936 pamphlet by J. W. Conway, "The Prevention and Correction of Left Handedness in Children", left handedness was described as a disease which is as troublesome and serious as rickets, small pox, and pneumonia in children. Owing to this, many medical and nonmedical personnel, so-called patients, were forcefully converted to right handed including King George IV of England. This same ideology can be traced to even Latin which is the origin for the word "left" which means "sinister" and obviously the "right" which always means "correct" or "perfect".

Despite this, there is complete paucity of literature for left-handed cardiac surgeons. An online literature search reveals only 4 articles related to "left-handed cardiac surgeons" [1–5] and negligible contribution from the Indian fraternity of cardiothoracic surgeons despite India having given some great left-handed cardiac surgeons. No surgical textbook narrates advice for left-handed cardiac surgeons. Hence, it is difficult to pass the torch of skills and techniques acquired and adapted by one lefty surgeon to pass on to other left-handed surgeons making the process of "Re-Inventing the Wheel" all over again. Unfortunately, surgical traditions and misconceptions continue to hamper left-handed training [6, 7]. Lack of information, or rather its dissemination, hinders change. Owing to the disproportionate numbers, many

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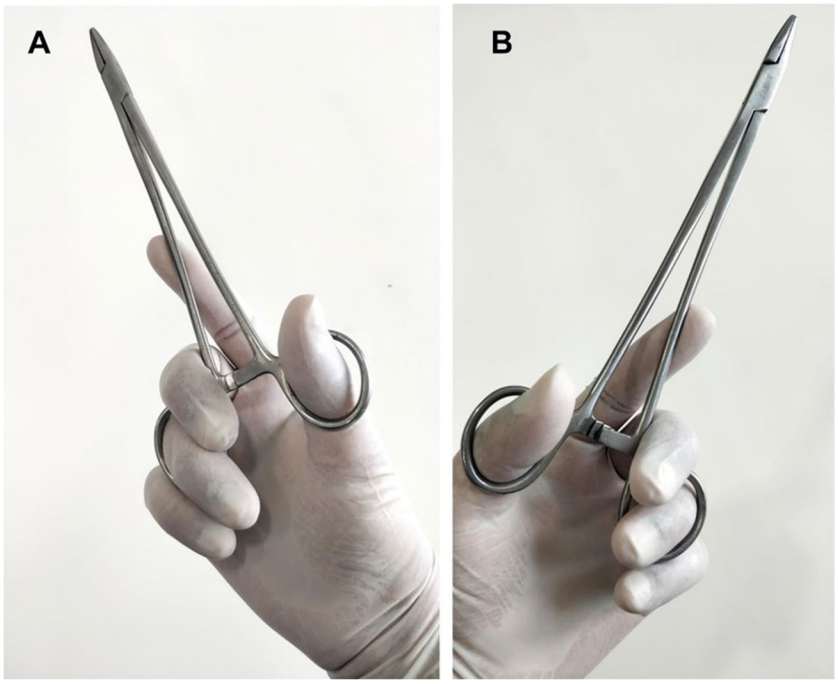

Fig. 1 **A** Triangular grip in the right hand—the normal motion of opening the rachets is abduction and extension of the thumb which is a normal motion of the thumb. **B** Triangular grip in the left hand—for opening of the rachets, the thumb needs to perform adduction and extension which is an unnatural motion, hence more difficulty for left-handed surgeons

left-handed trainees are isolated from left-handed surgeons, as it is very rare that every left-handed trainee is fortunate enough to get a left-handed trainer/mentor.

Speaking from a surgical point of view, the instruments can be grossly divided into 4 categories, namely cutting, grasping, clamping, and retracting instruments. Handedness and laterality are specifically in those instruments which have rachets (like artery forceps and needle holder) and/or simple pivot joint (like scissors) (Fig. 1). Those instruments which have a Castroviejo mechanism of action can be excluded as it has a different method of clamping and unclamping which is not affected by laterality. The palming technique is not possible with a left hand as one will have to make the "Pull" movement along with opening of the blades which is an unnatural movement for the left hand (Fig. 2).

The anatomy of the heart and positioning of the patient make it difficult for a cardiac surgeon to stand and operate from the left side of the patient which is the preferred site of operating for a left-handed surgeon as his/her dominant hand is closer to the instrument trolley and scrub nurse.

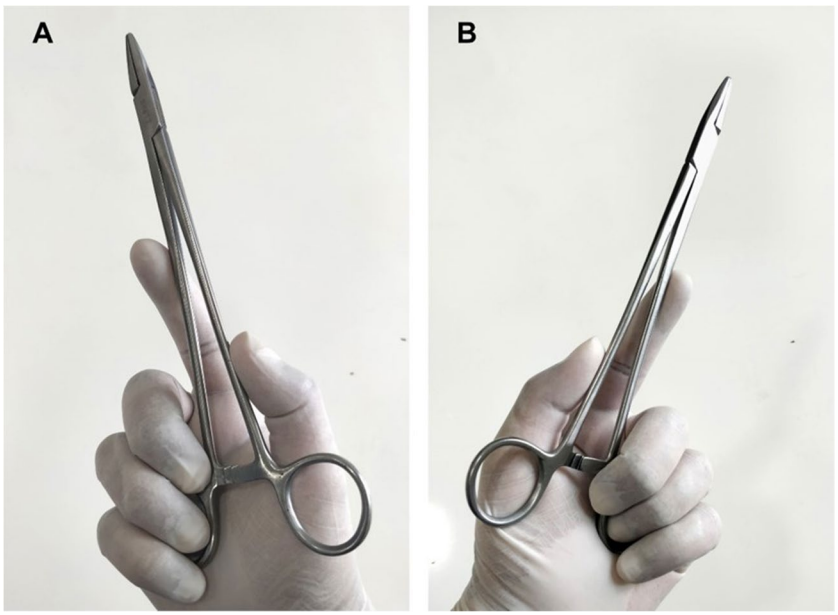

Fig. 2 **A** Palmer grip in the right hand—gentle push by the thenar eminence leads to opening of the rachets and thus opening of the instrument. **B** Palmer grip of the left hand—push of the thenar eminence closes the rachets more firmly; thus, opening of instrument is not possible. Hence, palmer grip cannot be used by the left hand unless left-handed instruments are used. Thus, handling of instruments by the left and right hand is not merely a mirror image

The solution

It can be crudely stated that the dominant hand is the one which is more equipped to do precise work and that gives rise to laterality and handedness. An ambidextrous person is the one having almost the same precision in doing finer work by either of his/her hands. Only 1–2% of the population throughout the world are genuinely ambidextrous. Firstly, it should not be considered taboo, and unless and until a person is a true ambidextrous, he/she should not try to become right handed. Though it is true that life of a right-handed surgeon is simpler, a left-handed person masquerading as a right-handed person takes more time, effort, and energy in doing the same task which he/she can accomplish easily by applying different maneuvers with the left hand. Moreover, the dexterity and the range of motion might not even reach to the extent until which a real right-handed person may reach. As the end result of which, a surgeon looses confidence in himself/herself and stays at a suboptimal level than his/her true potential. Several maneuvers or adjustments have been advocated for the benefits or advantage of the left-handers which encompass the scope of preoperative preparations including the specific instruments, specific maneuvers, patient positioning, and also including but not limited to core operative steps. These are only in the form of recommendations of individual surgeons from their own clinical experience rather than guidelines for operating.

Preoperative preparations

Instruments

Yes, it is a universal fact that left-handed instruments do exist and are made by many surgical companies throughout the world but the cost of those instruments range from 1.5 to 2 times the usual cost owing to its decreased demand [8]. It is difficult for a surgeon to expect such costly instruments in every surgical setup where he/she is working. If a surgeon himself/herself buys a set, then it is possible, but majority of the times, when a young cardiac surgeon trainee arrives in a hospital, neither he/she is in a state to buy such costly instruments nor is he/she a state for negotiations with hospital management to acquire left-handed instrument set. Thus, the burden comes on to senior surgeons who are training that at least one set of left-handed instruments comprising basic instruments like artery forceps, needle holder, mosquito forceps, and scissors of different sizes to be acquired and used as part of training of left-handed surgeons. Palming is not possible for left-handed surgeons as an alternative to it; "Partial Palming" is very helpful especially in case of quick locking and unlocking of the rachets and taking multiple sutures like in a valvular case (Fig. 3).

Fig. 3 Partial palming by the left hand: the ring finger is locked in the finger bow but the other bow is caught between the thumb and index finger, thus helping in quick closing and opening of the rachets with ease by giving gentle push at the thumb

Nursing assistance

As per routine protocol, before the induction of any surgery, the whole team of cardiac anesthetists, perfusionists, and scrub nurses should be told in brief about the procedure steps and the roles they play in each of those steps. This becomes more important when a surgeon is left handed especially from the scrub nurse point of view as mishaps from his/her side may lead to unwanted delay and at time disastrous consequences. Moreover, it is an observation that unlike right-handed surgeons, left-handed surgeons tend to have different steps and varied techniques amongst each other for performing maneuvers.

If the hospital has a set of left-handed instruments (which is highly recommended), those should be opened prior to the surgery and the surgeon should be informed about the same.

It must be duly noted by the scrub nurse as holding a forehand needle for a right-handed surgeon is translated to holding a backhand needle for a left-handed surgeon and vice versa. Even the forward angulation of the needle is accordingly. Repeated mishaps in loading backhand and forehand

can lead to delay in important steps and cause irritation to the operating surgeon.

The dominant hand of a left-handed surgeon is away from the scrub nurse; hence, the hand in which the needle holder/scissors and the forceps are held is opposite to that of a right-handed surgeon. This fact should be kept in mind while giving instruments to the surgeon at every step and it should not follow the routine.

At the time of draping, the anesthetist curtain is to be kept more cranially than the routine so as to allow the full range of motion of the left hand of the surgeon. This can be achieved by increasing the angulation of the fixed curtain bar or by placing two intravenous (IV) stands more towards the head side and placing a sterile curtain over it. This should be followed by proper sterile draping in a usual manner.

Intraoperative tips and techniques

Opening

Draping of the patient especially the overhead drape and curtain should be at a more angle and/or more cranially to allow the surgeon to work with his/her full efficiency without hindrance. Skin incision should be kept in a routine manner from 1 cm below the sternal notch until the xiphisternum. The assistant is asked to retract the superficial fascia in order to examine the anterior thyroid vein and to deal with it, hence the exposure of the interclavicular ligament. With retraction from the left side by the assistant with a Czerny's retractor or a Langenbeck's retractor, it is easier to visualize and to divide the interclavicular ligament. Score a midline over the sternum if needed.

Holding a sternal saw and doing sternotomy is a crude movement but it does need proper control so that the saw does not sway away from the anticipated sternal line. This can be achieved by holding the saw in the right hand as routine right-handed surgeons do and using the left hand to guide the saw as it is moving forward. Alternatively, the saw can be held by the left hand and reverse sternotomy could be done from the xiphisternum upwards.

Conduit harvesting

Conduit harvesting is one of the most important steps in doing coronary artery bypass grafting. The quality of the harvested conduit decides the fate of the patient; hence, dexterity should not be the reason for harvesting conduit sub-optimally and poor quality of the conduit.

For harvesting venous conduits, it is preferable for a surgeon to stand to the left side of the patient. This makes the incision of venous harvesting along the forehand of the left hand and it makes vein easier to expose. Alternatively, standing over the foot end is also preferred by some. A knife is preferred over scissors as it requires pulling action, thus a more natural movement and is easier to perform even with the nondominant hand if needed. Even closure of the leg is easier from downwards above in the forehand for a left-handed surgeon when he/she is standing over the left side of the patient.

For harvesting of the radial artery, the same as the venous conduit harvesting, it is preferable to stand over the radial side of the left hand and ulnar size of the right hand. For ease of understanding, here, we are describing radial harvesting over the left hand only. A normal right-handed surgeon prefers to stand to the ulnar side of the abducted upper limb at the time of radial harvesting. But it is an abnormal position for a left-handed surgeon as the line of dissection extends from rightward to leftward (distal to proximal). Thus, it is preferable for left-handed surgeons to stand over the radial side (head end) of the abducted upper limb. Steps of dissection of radial by the no touch technique will be the same. Here also, it is preferable to use a knife instead of scissors for skin incision. Closure of wound from distal to proximal part of the forearm from this position is quiet easy and straightforward.

Harvesting of the internal thoracic artery has the least change in ergonomics for surgeons with either of the laterality. The same positioning of the Favaloro's internal mammary artery retractor is encouraged and only the hands in which cautery pencil and forceps reside are to be changed. There are different techniques of harvesting the internal mammary artery, either can be done by a left-handed surgeon with ease following the same steps as a right surgeon. Harvesting from both the craniocaudal and caudocranial ends is accepted and can be done with ease as per the training and experience of the surgeon. It is a misconception that the right internal mammary artery is easier for left-handed surgeon as compared to his/her peers. In our experience, there is no major change except the mirror image of the anatomy of the right internal mammary artery.

Cannulation

Cannulation techniques can differ in relation to handedness, and as the assistant has a role to play, it is advised that the steps of suturing and cannulation should be properly discussed preemptively.

In aortic cannulation, a right-handed surgeon tends to make adventitial flap facing the caudal end by using scissors or a knife with the right hand. Making the flap facing the caudal end with scissors in the left hand is difficult and is not needed. Instead a flap facing the cranial end or, at times, the right side is easier and is encouraged. Different surgeons have different techniques for opening the aorta for cannulation either using a stab knife or a D-knife, both are accepted. If a cannula is angled metallic, a right-handed surgeon will firstly direct it facing the aortic valve and then rotate it 180°

towards the ascending aorta. This can be dealt in a simpler way by a left-handed surgeon by holding the adventitial flap in the right hand and doing aortotomy by knife from the left hand. At this point of time, it is preferable to have aortic cannula in the hands of the first assistant or at the overhead drape. Post aortotomy directly insert the cannula with the left hand facing the ascending aorta in a single motion.

For venous cannulation, superior vena cava and right atrium cannulation can be done in a routine manner as per the right-handed surgeon without much difficulty. It is the inferior vena cava cannulation which needs to be given more thought about. A normal right-handed person can retract the right atrium leftwards and cranially by his/her nondominant left hand, hence helping him/her take sutures of the inferior vena cava easily. Also when a surgeon himself/herself is retracting the right atrium, if any change in hemodynamics is noted, he/she can reflexly let the right atrium go and resume normal hemdynamics. But retraction of the right atrium becomes difficult for left-handed surgeons as it will cross his/her hands for attempting with the right hand making an awkward position to take sutures. Thus, an assistant is needed who can retract the right atrium while taking suture and he/she may not be as gentle as the surgeon himself/herself. We recommend the technique of sequential cannulation for going on pump. Firstly, the superior vena cava purse string and superior vena cava cannulation is done. Once the heart is one partial cardio pulmonary bypass with superior vena cava cannula, for sequential cannulation of the inferior vena cava, the inferior vena cava purse string and cannulation is done with a greater ease as retraction of the right atrium and hemodynamic alterations related to it are less likely when the patient is on partial cardio pulmonary bypass.

Coronary artery bypass grafting

Laterality and the anastomotic technique can be different for left- and right-handed surgeons primarily due to the positioning of the coronaries and the bulge of the heart obstructing the view while taking sutures due to change in laterality. These problems are more pronounced when coronary artery bypass grafting is performed off pump rather than on pump where the positioning of the heart is easier, and hence the anastomosis is easier. The following are 5 concepts for anastomosis that should be kept in mind irrespective of the laterality for a budding surgeon: (i) suturing should start from the most farther side and should come proximally (far to near); (ii) suture the inaccessible site/side away from the surgeon first; (iii) needle bite should be inside out from the coronary side especially if the arteriotomy site has a plaque in order to fix the plaque; (iv) heel should be secured first as it is very difficult to address the mishaps over the heel region afterwards once anastomosis is complete; (v) knot should be tied towards the most accessible site of the anastomosis (facing the surgeon). The above concepts are just to guide the surgeon and it should be borne in mind irrespective of the laterality of the surgeon. Along with this, it must be duly noted that ergonomics of the surgeon and the confidence he/she has gained from his/her surgical practice are more triumphant even though it may not follow the above concepts accurately and a trainee should try to take full advantage of the experience of his/her trainer.

Many left-handed surgeons tend to rotate sides especially while anastomosis over the right coronary artery or posterior descending artery. A left-handed surgeon tends to go to the left side of the patient to do it with ease but it is not always the case. With proper positioning of the heart and practice, one can do distal anastomosis of all the grafts by standing over the right side of the patient.

Valvular surgeries

Valvular surgeries are the one which a budding cardiac surgeon starts performing in the very initial stages of his/her career and even one of the first surgeries in his/her residency.

For mitral valve surgeries, the approach is similar to that of the right-handed individual. The resection of the valve is done in a similar manner. A small nick is made over the A2 segment of the mitral valve with the help of a knife which is then extended bilaterally to A1 and A3 with the help of scissors. Along with cutting of the anterior mitral leaflet, the chordae attached to it are also cut if necessary. The difficulty in cutting the mitral valve is seen especially in the posterior mitral leaflet. If we try to cut from P1 to P3 (from left to right), as then we will get a blind spot inferior to P2 and P3 segments where the chordae and its attachment will not be visible (Fig. 4). Hence, they needed to be excised

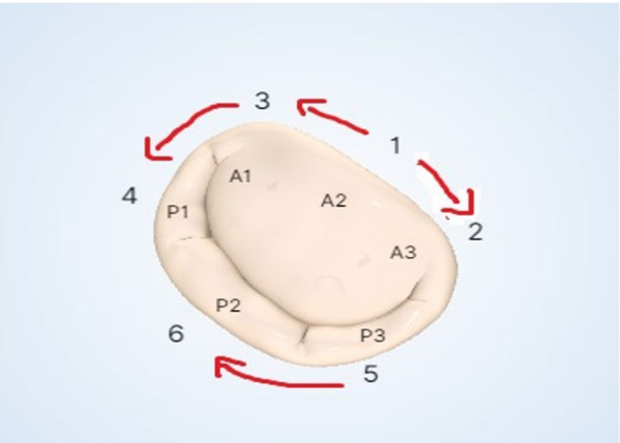

Fig. 4 Numbers and the arrow denote the sequence of cutting of mitral valve leaflets. Main problem faced is in the P2 and P3 area which can be reverted by using backhand scissors and cutting of P3 to P2 as shown in Fig. 5

from the P3 to P2 segment only but in a backhand manner of the scissors (Fig. 5). The posterior mitral leaflet (PML) stitches are taken backhand from P1 to P3 the same as a right-handed surgeon but difficulties arise in suturing the A1 and A2 region of the annulus. This can be overcome by taking forehand bites or hook bites by simultaneously pulling the sutures from P1, thus exposing the annular area of A1 and A2. It goes without saying that the larger the size of the left atrium, less struggle will be faced while doing mitral valve surgeries and this says the same for both the laterality. The left atrium can be closed in a similar fashion in single layer or double layer as per the routine practice by the surgeon from caudal to cranial end by forehand bites.

The anatomy of the aorta is such that the plane of the aortic annulus is angulated cranially which gives surgical advantage to the left-handed surgeon as it is easier to visualize and take sutures in the area of non-coronary cusp and right coronary cusp. The valve is cut as per routine starting from the most accessible point (left coronary cusp and right coronary cusp commissure) and extending throughout the annulus on either side. Suturing over right coronary cusp and non-coronary cusp for right-handed surgeons is difficult because the infoldings of the ascending aorta limit the range of motion up to a certain extent. This problem is not faced by a left-handed surgeon leading to easier manipulation of the sutures in the aorta from the left hand. The valve replacement and aorta closure is as per routine and rarely leads to problem due to laterality.

Closure

Closure, as we are well aware, is a very important step in surgery and should be done very meticulously. Sternal closure by left-handed surgeons can be done from either side with ease. For a surgeon standing on the right side, he/she needs to tilt the body slightly facing the caudal end of the patient and takes wires starting from the manubrium, and the rest closure follows as per routine steps. Whereas, for a surgeon closing the chest from the left side, he/she can easily close the sternum starting from the xiphisternum running upwards or the other direction. As standing on the left side is routine for an assistant, but as a chief surgeon, it is cumbersome to go from the right side to the left side of the patient for closure; hence, we suggest closure from the right side itself and make it a routine practice.

During closure of muscles and subcutaneous tissue, a surgeon from the right side should start closure from the caudal end to the cranial end and continue the same suture in a superficial subcutaneous plane from the craniocaudal end by using the continuous horizontal mattress technique and tying with its primary end. If two surgeons are closing the muscle and subcutaneous layers from opposite sides, then they cannot close simultaneously from both ends until and unless both are left handed or one has to do suturing in complete backhand. Subcuticular skin closure can be done in a routine manner from the right side starting from the cranial end.

Fig. 5 Backhand cutting by scissors

Trainee and trainers

Firstly for the lefty trainees, "DO NOT" miss the opportunity of being trained by a left-handed surgeon under any circumstances. By doing so, the long learning curve of left surgeons could be circumvented. Rather than mirror imaging the steps of right-handed surgeons, it is a lot easier to just adapt to the techniques already tried and tested by left-handed surgeons [9]. If regular working is not possible, even getting a brief visit and discussion over the technical aspects is also pretty rewarding especially for a young surgeon. There are other modes of learning like via YouTube or other channels over Facebook and Instagram which may not be specifically related to cardiac surgery but do help in getting insight about how to deal with different problems of dexterity like performing complex maneuvers and performing difficult suturing techniques. As the number of right-handed cardiac surgeons is in excess of left-handed ones, the probability of being trained under a right-handed surgeon is much more than the left-handed one. For trainers, it is advised to have a compassionate behavior towards the trainee and help him/her evolve through this tough journey of dexterity. Least a trainer can do it not to nag and force the young surgeon to convert his/her hand dominance. These problems can be easily overcome by practice and anticipation. An ergonomically different approach, more convenient for the left-handed trainee, may facilitate learning, enhance confidence, and increase surgeon satisfaction both for the trainer and trainee [6].

It is a hard fact that trainers of the best left-handed surgeons have been right handed. Accepting the change and help the budding surgeon to adapt and evolve over the technical difficulties inside the operating room and outside the operating room by making publication, video tutorials, or

wet lab training make the trainee and trainer overcome the fallacies of left handedness together [4].

Conclusion

Discrimination and hence the barriers to the progress of a left-handed cardiac surgeon do exist. At times, it may seem immutable and onerous, but with the help of proper guidance, proper left-handed instruments and various techniques adapted it can be overcome. More and more publications and chapters in standard books related to left-handed techniques must be encouraged. Most of the obstacles are encountered and overcame by some or the other surgeon before, should be emphasized to be published. Unless it is recorded and published, they will have to be resolved time and time again by different person as like reinventing a wheel.

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Declarations

Ethical approval Ethical approval has been taken for this study.

Informed consent This study was analyzing previously published data and no new patient data was reported; as a result, patient consent was deemed waived.

Statement of human and animal rights The study has been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Conflict of interest The authors declare no competing interests.

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