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Single Organ - Post Mortem Vascular Angiography – Review of the Literature of the Past with New Insights.

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ABSTRACT

We have attempted an experiment of performing a single organ post mortem angiography in a cadaver kidney using barium suspension, to understand the vascular anatomy and to justify the use of dilute barium suspension as a cheaper and easily available substitute to the more costlier commercially available agents. Through our small experiment we would like to emphasize that conventional fluoroscopic angiography using barium sulphate suspension for organ specific post mortem analysis is thus an alternative to CT angiography and is cost effective as demonstrated in this experimental procedure.
Keywords: Post mortem angiography; Cadaveric kidney; Barium sulphate suspension

Key Messages: conventional fluoroscopic angiography using barium sulphate suspension for organ specific post mortem analysis is thus an alternative to CT angiography and is cost effective as demonstrated in this experimental procedure.

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INTRODUCTION

We have attempted an experiment of performing a single organ post mortem angiography in a cadaver kidney using barium suspension, to understand the vascular anatomy and to justify the use of dilute barium suspension as a cheaper and easily available substitute to the more costlier commercially available agents. The study was aimed at demonstrating post mortem angiography with fluoroscopy as a viable and cheaper alternative to single organ post mortem CT angiography in developing countries. A kidney specimen which was isolated from a cadaver was selected for the experiment. It was noted that, there were two renal arteries leading to the kidney (Figure 1A). Barium sulphate suspension (95% microbar suspension) was diluted into a 50% solution and loaded in 20 ml syringes. The larger renal artery was directly cannulated at the mid renal artery level and the contrast was injected (Figure 1B). The proximal renal artery was clamped to avoid the reflux. The specimen was imaged under the video fluoroscopy (Shimadzu FlexavisionHB 850 ma, Japan).The lower accessory renal artery was cannulated distally and the contrast was injected in a similar fashion (Figure 1C). It was observed that there was a good flow of the contrast into the renal arteries upto the segmental, lobar and interlobar arteries. The contrast formed into a cast in the arteries before refluxing proximally into the abdominal aorta. The adequate visualisation of the arteries were obtained and the image was inverted to resemble the conventional imaging (Figure 1D).

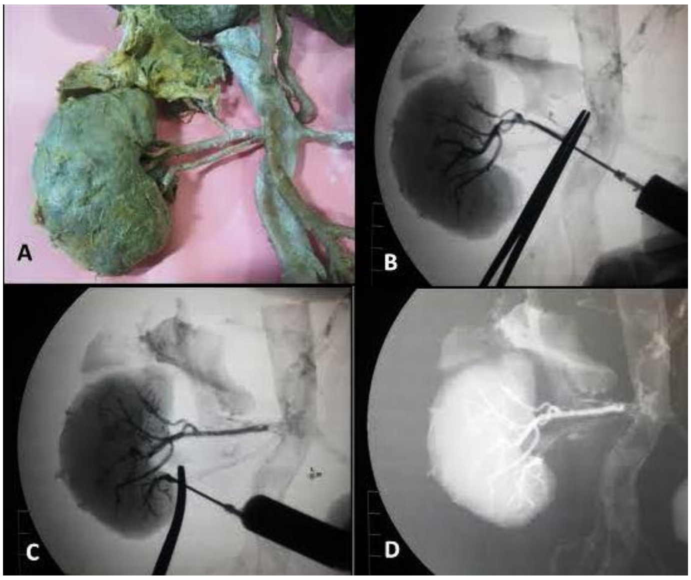

Fig 1A Cadaveric kidney specimen showing the two renal arteries leading to the kidney; 1B. showing the cannulation of the larger renal artery at the mid-level and the contrast was injected; 1C showing the distal cannulation of the lower accessory renal artery and the contrast was injected in a similar fashion; 1D showing the adequate visualisation of the arteries in the kidney and the image was inverted to resemble the conventional imaging.

DISCUSSION

In the present era of higher number of medicolegal cases with increasing number of road traffic accidents and rising number of litigations against the medical fraternity, it is imperative that in addition to the autopsy, post mortem CT and CT angiography needs to be performed. This is essential to diagnose the site of unexplained hemorrhage leading to hypovolemic shock and death. Other current indications of postmortem angiography include organ-specific analysis of the vascular patterns and anatomic variations, pathophysiological changes induced by unnatural causes, and experimental testing of a newer contrast agent [1].

Vascular casts were first used in the 16th century by Leonardo da Vinci, who attempted to understand the human vascular system by injecting wax into the cardia and then using maggots to free the cast from the surrounding flesh. Various experiments were conducted by De Graaf, Ruysch, and Lower in the 17th and18th centuries to understand the vascular anatomy. After X rays were discovered, post-mortem angiography was more widely used in the early 20th century leading to the development of newer methods to visualize the vascular system by injecting radio-opaque materials into the arteries. Schlesinger pioneered the methods to study coronaries in 1938 [2].

With the advances in cross sectional imaging modalities like computed tomography, post mortem angiography is more and more routinely used in the forensic investigations and patho-anatomy. Various methods have been developed to help the forensic pathologist/surgeonto determine the cause of death and in some cases to endorse or even substitute the conventional autopsy. Postmortem-Computed Tomography/ PMCT was first attempted in 1983, in a case of a diving fatality by demonstrating the distribution of gas by cerebral CT scan [3].

Various ways of performing the post mortem analysis include macroscopic and microscopic inspection of 3D casts after maceration of the surrounding tissue, conventional radiography, xeroradiography, CT, MRI, micro-CT, and scanning electron microscopy. Currently CT is the most commonly used tool in the postmortem angiography [1]. Due to low acceptance rate and higher cost of CT particularly in underdeveloped and developing countries, we require an investigation which can serve a similar propose as the CT angiography and it should be cost effective.

Two categories of perfusates can be used for postmortem angiography namely hydrophobic fluids which remain in intravascular space and aqueous media which extravasate and penetrate into the surrounding tissues [4]. Different injection materials used in postmortem angiography are subgrouped as corpuscular preparations, oily liquids, hydro-soluble preparations, casts, and miscellaneous [1].

Silke et al listed the various methods used in the past, to perform the post mortem angiography [1, 4].

Oily Liquids were first used in 1933, by Parade, who injected the Jodipin (iodized oil) to study the coronary arteries. Other oily preparations that have been used include Dionosil, Lipiodol Ultra Fluide or mixture of diesel oil and paraffin oil [1]. SilkeGrabherr, attempted to study post-mortem circulation in two dogs and a cat in 2005by initially perfusing the vascular system with diesel oil and then performed the angiography by injecting a lipophilic contrast agent Lipiodol Ultra Fluide, in order to establish optimal perfusion conditions for high-resolution postmortem angiography, so as to enable dynamic visualization of the arterial and venous systems [4].

Postmortem angiography can be conducted on single isolated organs or whole body. For single organ technique, removed organs were treated either with radiopaque silicon rubber or with suspensions of barium sulphate in gelatin or agar. Other techniques used in the post-mortem perfusion of single organs included injection of contrast agent into single organs in situ and then removal of the organ for imaging or using Schlesinger's technique of cannulating coronaries of a freshly removed heart, which is first warmed in a water bath and then flushing the coronaries with warm physiologic saline at a pressure of 150 mm Hg, to flush out clots and later perfusing with a warm slurry of lead–agar or barium–gelatin at the same pressure. Other methods employed utilised keroseneora mixture of diesel oil and paraffinoil or combining the perfusion and fixation [1].

Whole body diffusion studies to evaluate the complete vascular system were performed mainly in animal embryos and in human fetuses or embryos shortly after the death [4] and techniques used were similar to those used for single organs. However Stoeter and Voigt in 1976, demonstrated a new technique in which radiologically controlled, discontinuous injection of the contrast agent was performed and angiography was performed at intervals which allowed the complete vascular system to be evaluated [1]. The first documented report of the whole-body perfusion angiographic study showing the arterial system of a whole adult human cadaver was documented in 2005 [1].

Quality of angiograms obtained can be suboptimal if there is incomplete vascular filling, particularly in the micro-vasculature if larger sized particles are used or the air bubbles get inadvertently injected producing artefacts. Quality can be improved and artefacts can be avoided by changing or modifying the techniques and choosing correct particle size of the contrast agent. Fluid media rather than viscous agents should be used as the latter penetrate the microcirculation poorly . Contrast agents like micropaque should be used if microcirculation is to be visualised. Prior perfusion of the vascular system with oil or saline before injecting the contrast agent or slow and continuous injection of the contrast agent may help improve the quality. Time elapsed after death and administration of perfusate can influence the result of postmortem angiography. Most methods can be used for 24 hours after death, however beyond 24 hours, choice of agents/method become limited due to extravasation. The death-to-perfusion time and the perfusion-to-radiography interval can be extended by using oily liquids, which are retained longer by vessels than other aqueous or non-oily ones [1].

Organ-specific analysis of vascular patterns and anatomic variations is still one of the most widely indicated use of post mortem angiography. It is most widely performed to understand the vascular anatomy of heart, to study arteriosclerotic changes, to perform cast angiography in the diagnostics of graft complications in patients with fatal outcome following CABG(5) and to study the vasa vasorum of the aorta. It is also used to understand the vascular anatomy of other organs like testes, spleen, upper and lower extremities, kidney, brain and mesentery; to evaluate cerebral aneurysms and arteriovenous malformations [6]., subarachnoid bleeding [7]; to study tumor vascularity, splenic and aneurysms, , esophageal varices, evaluate vertebral and spinal arteries. It is also used in medicolegal cases to study the effects of hanging on the neck vessels, of electrical shock on vessels within affected regions ofthe skin and to diagnose intracranial bleeds in a battered baby syndrome. Commonly, the low-molecular-weight contrast agents are used to delineate the microcirculation. Microangiography of vascular casts is currently the most important research tool in the field of angiogenetics.

Post mortem MDCT-angiography(PMCTA), has now become the useful adjunct to view the pathology of the vessels [8]. PMCTA is capable of detecting cerebral aneurysms in a non-destructive manner, which is otherwise difficult to identify, particularly in diagnosing the vertebral artery tear following trauma [7]. there are case reports documenting usefulness of PMCTA in diagnosis of a post-radiotherapy ureteric–arterial–enteric fistula presenting as massive rectal and vaginal bleeding as a cause of death, diagnosed prior to the autopsy [9]. It is also helpful in localizing the bleeding caused by unnatural injuries such as stabwounds and gunshots. PMCTA findings as evidence of traffic accident-related fatal injury are also helping the forensic department to diagnose the cause of death [10].

Due to the cost factor, use of PMCTA for forensic (medicolegal) or pathological autopsies in countries like India is still restricted. However through our small experiment we would like to emphasize that conventional fluoroscopic angiography using barium sulphate suspension for organ specific post mortem analysis is thus an alternative to CT angiography and is cost effective as demonstrated in this experimental procedure. We attempted the use of barium sulphate in a single organ – the applications in whole body vascular imaging can be further explored.

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