Title: STERNAL RETRACTION AND PULMONARY ARTERY CATHETER COMPROMISE

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Introduction. Since 1970, when Swan and associates[1] reported the bedside use of a No. 5 French balloon-tipped pulmonary artery catheter (PAC), use of this valuable monitoring tool has increased exponentially. Unfortunately, in some patients this information is unpredictably lost when sternal retractors are used to expose the heart. For this reason, we followed forty-one consecutive cardiac procedures requiring sternal retractors for visualization. Chest X-rays demonstrating the position of the PACs were taken before and after sternal retraction. These X-rays revealed mechanical compromise in 45% of the subclavian placed PACs associated with loss of the PA and CVP information, whereas none of the internal jugular or supraclavicular placed PACs were so affected.

Methods and Materials. Two types of PAC introducer kits were used: Arrow® (21) and Cordis® (20). Four types of sternal retractors were used: Collins,® Burford,® Ankeney,® and Cooley.® Choice of the insertion site and introducer kit was made by either the cardiologist (ICU) or anesthesiologist (OR) solely on the basis of perceived risk to the patient and ease of insertion.

Prior to sternotomy, anterior-to-posterior chest X-rays were taken in the ICU or in the Operating Room. The X-rays confirmed proper placement of the PACs and removed any concern about pneumothorax. Following sternotomy repeat chest X-rays were taken after the sternal retractors were optimally expanded for desired visualization while the pulmonary artery and central venous pressures were monitored. Permanent loss of waveforms was documented only after multiple attempts to irrigate the lines failed to reestablish previous normal waveforms. In every case of lost waveforms, all waveforms could be reestablished with removal of the rib spreaders and irrigation of the monitoring ports.

Results. Forty-one consecutive cardiac patients having PAC monitoring received chest X-rays before and after insertion and opening of sternal rib spreaders. Table 1 summarizes the results for five separate insertion routes. Listed are the total number of insertions for each site with the incidence of lost PA and CVP waveforms. Maximum sternal retractor opening distance is also noted. Special attention should be paid to the data for the left subclavian and right subclavian insertion routes. Forty percent of the left subclavian group (6 of 15) and 60% of the right subclavian group (3 of 5) suffered loss of the PA and CVP waveforms during sternal retraction.

Discussion. Early authors documented that anatomical variations in the junction of the external jugular vein and subclavian vein could lead to acute angulation and compromise of a PAC. However, Noel[2] first suggested that PAC compromise was probably due to retraction of the sternum by the rib spreaders. Review of Table 1 reveals that 45% of the PACs placed via the subclavian approach kinked after the rib spreaders were inserted. This terminated any further PA or CVP waveform information. Furthermore, in every case where the waveforms were lost, kinks along the PAC introducer sheath complex could be detected. In contrast, none of the PACs placed via the right internal jugular, left internal jugular or right supraclavicular approach demonstrated loss of PA or CVP waveforms with expansion of the sternal retractor. Attempts to reestablish better position of the sternal retractors did not result in the salvage of any previously lost waveforms. Maximum distance of retractor spread was similar for all groups. Four types of sternal retractors were used; none offered superiority over the others.

In summary, PAC placement was evaluated using five different insertion sites. Compromise of the introducer sheaths with loss of PA and CVP waveforms was clearly demonstrated in 45% of the PACs placed via the subclavian approaches. PACs placed via other routes functioned well, although distortion of some catheter sheaths did occur. We suggest that PACs inserted for surgery requiring sternal retractors be placed via non-subclavian approaches if at all possible until design changes can be made in the PAC introducer sheaths.

References.

1. Swan HJC, Ganz W, Forrester J: Catheterization of the heart in man with the use of a flow-directed balloon-tipped catheter. N Engl J Med 283:447-451, 1970
2. Noel TA: Pulmonary artery sheath malfunction with sternotomy. (Letter to the Editor) Anesthesiology 61:633-634, 1984

Table 1 SUMMARY OF FORTY-ONE CASES

Site of PAC/**** Introducer* Sheath Insertion	Distance Between Sternal Blades Mean ± SD (range)	Number of Patients n	Incidence of Lost PA** and CVP*** Waveforms n (%)
Right internal jugular	12.69 ± 1.06 (11.0 - 15.3)	16	0
Left Subclavian	12.89 ± 1.25 (11.5 - 16.0)	15	6 (40%)
Right Subclavian	12.10 ± 1.28 (10.0 - 14.0)	5	3 (60%)
Left Internal jugular	11.67 ± 0.24 (11.5 - 12.0)	3	0
Right Supra-clavicular	12.75 ± 0.25 (12.5 - 13.0)	2	0
TOTAL	12.62 ± 1.13 (10.0 - 16.0)	41	9 (22%)

*Introducer kits were made by either Arrow International, Inc. or Cordis Corp.
**Pulmonary artery
***Central Venous pressure
****Pulmonary Artery Catheter