The use of retrievable inferior vena cava filters in the trauma population

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OBJECTIVE: To determine if the use of retrievable filters resulted in an increase in the placement of inferior vena cava (IVC) filters in trauma patients.

DESIGN: All patients who underwent IVC filter placement at Yale-New Haven Hospital, New Haven, Connecticut, USA between the years 1999 and 2004.

SETTING: Academic, level 1 trauma centre.

PATIENTS: Included in the present study were 202 trauma patients and 676 nontrauma patients.

INTERVENTION: IVC filter placement.

MAIN OUTCOME MEASURE: Demographics, indications, complication rates and type of IVC filters placed in trauma patients versus nontrauma patients were evaluated.

RESULTS: The present study determined 45.4% (n=92) of trauma patients undergoing IVC filter placement were younger than 40 years

of age, compared with 7.8% (n=53) of nontrauma patients. The most common indication for IVC filter placement in trauma patients was prophylaxis (n=162, 80.2%), while in the nontrauma patients only 11.4% (n=77) of patients underwent prophylactic filter placement. The number of retrievable filters used in trauma patients increased from 46.7% in 2001, the year they became available, to 78.9% in 2004. The use of retrievable filters similarly increased in the nontrauma population from 35.9% in 2001 to 78.3% in 2004. Approximately 24% of the patients that underwent IVC filter placement at Yale-New Haven Hospital were categorized as trauma patients. The complication rate for this time period was 0.5% (n=1) in the trauma population versus 3.7% (n=26) in the nontrauma population.

CONCLUSION: The overall number of IVC filters placed in trauma patients did not dramatically increase with the introduction of retrievable filters, suggesting that the indications for the use of IVC filters have not changed.

Key Words: *Prophylactic IVC filters, Retrievable IVC filters, Trauma population*

In the past decade, there have been significant strides in the advancement of inferior vena cava (IVC) filter technology, which has enhanced therapeutic options for patients. In 2001, the first retrievable IVC filter became available in the United States, making it possible to prevent a fatal pulmonary embolism (PE) in appropriate patients without the long-term complications of permanent filter placement (1,2). Since the introduction of retrievable filters, there have been many studies documenting their safety and efficacy, but their pattern of use in different patient populations remains ill-defined (3-6).

In particular, the use of prophylactic IVC filters in high-risk trauma patients continues to be a source of ongoing debate. Some institutions have reported a decrease in the incidence of PE in trauma patients with prophylactic IVC filters, while others have reported no change or an increase in the incidence (7-10). Despite this uncertainty, the number of prophylactic IVC filters placed in the trauma population appears to have increased over the past several years (11-13). The question of whether the option of retrievability had any impact on the actual number of IVC filters being placed in trauma patients has yet to be evaluated.

We recently reported an overall trend at Yale-New Haven Hospital, New Haven, Connecticut, USA, toward an increase in the use of retrievable IVC filters, as well as an increasing propensity for the placement of prophylactic filters (14). The trauma population, with its diversity, nature of patient injuries and younger age group, may have played a significant role in these observations. The changing patterns at the hospital

prompted us to evaluate what impact the availability of retrievable IVC filters had on filter placement in the trauma population during the years surrounding the time they were introduced.

METHODS

The present study used a hospital database to compile a list of all patients who received an IVC filter between the years of 1999 and 2004 at Yale-New Haven Hospital. After approval by the Yale Human Investigation Committee and the Institutional Review Board, a chart review of the 878 patients who underwent IVC filter placement was performed. These patients were divided into trauma and nontrauma categories based on admitting service and admission diagnosis. The patients' data were then analyzed with respect to demographics, indications, complication rates and type of IVC filters placed.

RESULTS

Of the 878 patients who underwent IVC filter placement at Yale-New Haven Hospital, 202 were trauma patients and 676 were nontrauma patients. The trauma and nontrauma patients were divided into three age groups: younger than 40 years, between 40 and 60 years, and older than 60 years (Figures 1A and 1B). The largest age group undergoing IVC filter placement in trauma patients was younger than 40 years of age, with 45.5% (n=92) of trauma patients, compared with 7.8% (n=53) of nontrauma patients. Conversely, the largest age group in the

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Figure 1) The demographics of patients undergoing filter placement. **A** Trauma patients. **B** Nontrauma patients. The largest age group in trauma patients was younger than 40 years. The largest age group in nontrauma patients was older than 60 years

Figure 2) The most common indications for inferior vena cava filter placement. **A** Contraindication to anticoagulation. **B** Prophylaxis. The most common indication for nontrauma patients (lined bars) was contraindication to anticoagulation, while in trauma patients (hatched bars) it was prophylaxis

nontrauma population was greater than 60 years of age, with 63.2% ($n=427$) of nontrauma patients, compared with 22.3% ($n=45$) of trauma patients.

The two groups of patients were then evaluated based on their indications for undergoing filter placement (Figures 2A and 2B). The most common indication in trauma patients was prophylaxis, with 80.2% ($n=162$) of trauma patients, while in the nontrauma patients only 11.4% ($n=77$) of patients had a prophylactic filter placed. The most common indication for

Figure 3) Number of filters placed. **A** Number of filters placed in trauma (hatched bars) and nontrauma (lined bars) patients. **B** Number of trauma admissions. The number of filters placed in trauma patients per year remained relatively constant despite the availability of retrievable filters in 2001. The number of trauma admissions per year was also constant throughout the study period

placement of an IVC filter in the nontrauma patients was contraindication to anticoagulation, with 53.5% ($n=362$) of nontrauma patients, compared with 15.8% ($n=32$) of trauma patients.

The overall number of IVC filters placed per year in the trauma and nontrauma patients was analyzed to determine if the availability of retrievable IVC filters in 2001 affected the number of trauma filters placed. The percentage of patients who underwent IVC filter placement each year in the trauma population remained relatively unchanged, with a mean of 24.6% (Figure 3A), despite the introduction of retrievable IVC filters to the hospital. The overall number of trauma patients admitted to the level 1 trauma centre was obtained from an institutional database established in 2000. The number of trauma admissions during the years 2000 to 2004 remained constant, suggesting the number of trauma admissions is not an independent factor in these findings (Figure 3B).

To evaluate whether there was a greater use of retrievable IVC filters in the trauma population compared with the nontrauma population, the number of retrievable filters used in the two study groups after retrievable filters became available in 2001 was examined (Figure 4). These results demonstrate that retrievable IVC filters were increasingly used in both the

trauma and nontrauma populations. The percentage of retrievable IVC filters used in the trauma population per year increased from 46.7% to 78.9% during the years 2001 to 2004. A parallel increase in the use of retrievable IVC filters was demonstrated in the nontrauma population, with an increase from 35.9% to 78.3%.

The complication rates for IVC filter placement were also compared between the two groups. The trauma population had a low complication rate of 0.5% (n=1) compared with 3.7% (n=26) in the nontrauma population. The documented complications in the nontrauma population were groin hematoma, malposition of the filter, occlusion of the IVC and recurrent deep venous thrombosis (DVT). The one complication in the trauma population was penetration of the filter through the IVC. Despite these complications, there were no mortalities associated with placement of the IVC filters during the present study.

DISCUSSION

Over the past 25 years, technological advancements in the design and composition of IVC filters resulted in a steady increase in their deployment. Before the introduction of the first Greenfield filter in 1973, patients generally underwent an open ligation of the IVC, which was accompanied by a substantial operative mortality rate of 14%, a recurrent PE rate of 6% and chronic venous stasis rate of 33% (15). These rates were substantially lowered in the era of IVC filter placement, with recurrent PE rates of 4%, vena cava patency rates of 96%, and mortality and morbidity rates of less than 1% (12,13). IVC filter technology has continued to undergo modifications over recent years, with improvements in magnetic resonance imaging compatibility, modes of venous access and the ability to accommodate various vena cava diameters. With the recent availability of retrievable IVC filters, technology has advanced further, giving physicians even greater flexibility in the management of venous thromboembolic disease.

The three types of retrievable filters currently available in the United States are the Günther Tulip filter (Cook, USA), the Bard recovery filter (Bard, USA) and the OptEase retrievable filter (Cordis, USA) (16). In 2001, the first retrievable IVC filter was approved for removal after 10 days of use. Since then, there have been many reports on the safety, efficacy and outcomes associated with the use of these filters. The technical success rates for retrieval after the 10- to 14-day recommended period were reported to be as high as 80% to 100% (3,5). There have also been reports of safely removing these filters several weeks after the current recommended time interval (17). Clinical trials are now underway with a new retrievable IVC filter that is designed for a longer duration of treatment. With these recent advances in IVC filter design, it is not surprising that there could be revolutionary changes in the patterns of use and indications in the placement of IVC filters.

The absolute indications for IVC filter placement are patients with documented thromboembolic disease who either cannot receive anticoagulation or who do not respond to anticoagulation. Relative indications include prophylactic filter placement in patients who are considered high-risk for DVT or PE, the presence of a large proximal DVT or venous lysis (15). Our data demonstrate there was a larger percentage of prophylactic filters placed in the trauma population compared with the nontrauma population. The higher percentage of prophylactic filters placed in trauma patients is largely due

Figure 4) Percentage of retrievable filters placed in trauma (hatched bars) and nontrauma (lined bars) patients. This graph demonstrates that both trauma and nontrauma populations had a significant increase in the use of retrievable filters after they became available in 2001

to the nature of their injuries, which often require longer periods of bed rest and immobilization.

Early studies established a decrease in the rates of PE in high-risk trauma patients without DVT after the placement of prophylactic IVC filters. In contrast, there have been published studies that did not show favourable results (10,18). This indication will continue to be controversial until randomized studies are performed to establish evidence-based guidelines regarding prophylactic IVC filters. Although it was beyond the scope of the present study to evaluate the incidence of PE in trauma patients undergoing prophylactic IVC filter placement, our results demonstrated that 80% of trauma patients underwent IVC filter placement for prophylactic indications, and supported the need for further studies on the safety, efficacy and cost-effectiveness of this practice.

Despite the finding that most trauma patients underwent IVC filter placement for the relative indication of prophylaxis, they had a significantly lower complication rate associated with filter placement compared with the nontrauma population. Our data also demonstrate that the trauma population that received IVC filters is comprised of much younger patients than their nontrauma counterparts. The prevalent older age group in the nontrauma population likely contributed to the higher complication rate of 3.7%, versus 0.5% in the trauma population, due to the presence of comorbidities in the older age group of nontrauma patients. Our overall complication rates were comparable with previous studies that reported a complication rate of 2.9% in patients undergoing IVC filter placement. However, the complication rate for the nontrauma patients was significantly lower than previous reports in all types of patient populations (19). Complications associated with IVC filter placement include hematoma or thrombosis at the insertion site, vascular injury, IVC thrombosis, air embolism, pneumothorax, hemothorax, filter migration, filter fracture, IVC perforation and malposition (15). The most common complication in the nontrauma patients during the present study was groin hematoma, while the single complication in the trauma population was penetration of the filter through the wall of the IVC. This patient was examined in the operating room, where it was discovered that two tails of the

filter had penetrated the side wall of the IVC. The tails were trimmed down, the filter was readjusted and a primary repair of the IVC was performed without further complications.

We expected the availability of retrievable filters to have a greater impact on the number of filters placed in the trauma population compared with the nontrauma population. This assumption originated from the results of our previous study (14), which found a significant increase in the use of retrievable filters during this study period. Due to the trauma population's younger demographics and the greater number of prophylactic filters placed, we hypothesized that the vast increase in retrievable filters placed were mainly from those placed in trauma patients. The present study proved our hypothesis to be incorrect. Both the trauma and nontrauma population had a similar increase in the placement of retrievable filters after they became available in 2001. In addition, the number of trauma filters placed did not significantly increase after the retrievable filters were introduced. This suggests that recent technological advancements have altered the application of IVC filters for all patients undergoing filter placement, but has not had a greater impact on the trauma population compared with the nontrauma population, as we initially anticipated.

The limitations of the present study included the lack of long-term follow-up that recorded complication rates and retrieval rates. This was difficult to obtain due to the limitations in maintaining current records on patients after discharge from the hospital. For future studies, further efforts will be made to maintain these data to better determine the overall retrieval rate for these filters, and whether they are being used in a cost-effective manner.

CONCLUSION

The trauma population differs largely from the general population undergoing IVC filter placement with respect to demographics and indication for filter placement. Although retrievable IVC filters provide the option of protection from a PE without the complications of long-term filter placement, they have not increased the overall use of IVC filters in the trauma population.

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