



# Advances in instrumentation and enhancing technology for direct anterior hip replacement surgery

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**Abstract:** This review discusses the numerous advances in technology and instrumentation that have contributed to the success and popularity of the direct anterior hip replacement. Topics covered include: pharmaceuticals, anesthesia, surgical energy, fluoroscopy, navigation, instrumentation, and operating room equipment. These technologies are discussed and presented with supporting science as well as the authors' preferred methods of implementing this technology an instrumentation into practice.

**Keywords:** Direct anterior; total hip; anterior hip; technology; instrumentation

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## Introduction

The popularity of the anterior hip approach as an option for hip replacement is undeniable. Many patients request the procedure specifically as the approach becomes more and more popular. For the younger generation of graduating Orthopaedic Surgeons in the US, many are coming to know the direct anterior approach (DAA) as the common approach depending on their residency environment. It was rarely taught as recently as just 10 years ago.

Along with the popularity of the procedures there have been advances in Technology and Instrumentation that have enabled and promoted the success and popularity of the procedure. This section will focus on those recent improvements that have been made to address specific concerns and complications of the procedure as well as to continually improve the procedure.

The operative tables used for DAA vary from basic to complex and will be covered in other sections of issue.

## Blood management

The technologies associated with blood management have

benefitted all of orthopaedic surgery, but especially DAA surgery, because without careful hemostasis the procedure has the potential for significant blood loss (1). There are two main categories of blood management: pharmaceutical and physical. Blood management is a very significant topic due to the circumflex vessels that can provide impressive blood loss if not addressed appropriately.

The pharmaceutical management of blood loss has seen significant advances with the widespread adaptation of the use of tranexamic acid (TXA), and this alone has had significant improvements in the minimization of blood loss (2). It can be administered intravenous (IV), topically, or orally. At the current time IV use is the most common in the United States, but oral administration is showing promise to be as effective as IV with a substantial cost savings. For patients with contra-indications to systemic use, TXA can be used topically with positive results. The authors strongly recommend the use TXA for DAA surgery.

Other pharmacological interventions to improve outcomes from DAA can be optimization of pre-operative hemoglobin levels as directed by the medical team. There are pharmacological agents such as Epo-poten and Iron than can help optimize patient pre-operatively. We

recommend consultation with your medical service to optimize all pre-operative candidates with pre-operative laboratory abnormalities.

Some practitioners request hypotensive anesthesia in an effort to minimize bleeding intra-operatively through anesthesia (3). The authors do not recommend hypotensive anesthesia as there is substantial literature in regards to shoulder surgery that the cerebral blood flow is affected greatly with hypotensive anesthesia (4). In the geriatric population undergoing total hip arthroplasty this could lead to further cognitive impairment, and the authors do not recommend hypotensive anesthesia, but instead recommend to the anesthesia team to maintain the blood pressure near the patient's baseline pressure. This point is important to recognize- if the patient runs an elevated blood pressure pre-operatively, maintaining them at 'normal' pressures may actually be hypotensive for that particular patient.

The physical items that can aid in blood management include various tools. The common electrocautery has a place in DAA surgery, but there are newer innovations that can also aid the DAA surgeon. The author's most preferred technological assistants in the bipolar cautery sealer (5). The bipolar cautery sealer that we employ has shown to be an effective tool for our surgeries and we prefer it for all DAA cases. There are supporting papers and well as studies that show it's use to be equivocal, but we find the improvement in visualization and hemostasis to be a welcome assistant to our surgeries (6-10). We feel that this technology could also be the most useful to the surgeon that is establishing confidence with a new procedure.

There are also newer variants of traditional cautery such as plasma blades that claim to improve hemostasis (11). These instruments typically have more focused energy that traditional mono-polar cautery resulting in lower temperatures and limited thermal injury to tissue. We must also caution surgeons to the risks of using traditional cautery around final implants as there is data indicating that thermal injury to final implants may help accelerate corrosion and sequela of metal damage (12).

## Imaging

One of the great advantages on the DAA is the ability to use fluoroscopy throughout the case. This topic is covered in detail in another section. With traditional fluoroscopy there have been technological advances that enhance the standard fluoroscopy. There are tablet and smart phone-based apps that help correct for magnification and parallax

to improve the accuracy of the information presented to the surgeon intraoperatively (13). The ability to template pre-operatively digitally is similar to what has been available for all total hips, but the improved interface with the intra-operative fluoroscopy can help augment the templating.

Navigation is also another facet of technology that has evolved to accommodate the DAA. Navigation has shown to be equivocal for the routine total knee arthroplasty, but it is agreed that there are specific cases where it can be very useful, i.e., for deformity or retained hardware. Navigation for DAA may have a similar use, that has yet to be born out scientifically. Many of the navigation system for DAA require a pre-operative CT scan, and thus increase the radiation that the patient is exposed to (14,15). We feel that the use of standard fluoroscopy is very useful to help obtain adequate position of components, but intra-operative navigation may have benefits that could benefit the inexperienced surgeon, or help with an anatomical complex patient, but there may also be increased morbidity from the need to place percutaneous pins outside the standard incision. There are also other newer technologies such as augmented reality that blend a virtual environment through video output to either show a 'virtual' implant in the surgical field, or else show the actual implant through a virtual surgical field (13,16-18). Some of these technologies may help improve the accuracy, consistency, and quality of DAA.

## Analgesia

Another area where technology has greatly increased the overall success and popularity of the DAA is in pain control. Continuous infusion catheters have been shown to decrease pain postoperatively (19). We have found excellent results using the intra-articular injection championed by Dr. Dalury, and thus we have seen little need for additional pain control modalities as this has allowed us to promote a rapid recovery protocol (20). Another variant of the peri-articular injection that has recently been advocated for by some is the liposomal based bupivacaine solutions. Our experience with it involves minimal benefits with significant cost, and this has been born out in a recent meta-analysis (21). Regional anesthesia can also be of use in the improvement of pain control. The authors continue to use general anesthesia for complete muscular relaxation to aid with femoral exposure, but some practitioners will also use regional anesthesia as adjunct pain control.

## Implants and instrumentation

The role of the implant and the instrumentation has also seen advances and adaptation for the direct anterior approach. It has been noted by some that the increase risk of femoral fracture during the procedure could be due to more traditional shaped implants (22). This has lead manufactures to promote 'mini' stems, or curved shortened stems to help mitigate this complication (23). A recent study has shown superior results from more traditional stem than with newer smaller stems (24). The authors prefer to use traditional type stems that have reduced lateral shoulders to aid with the implantation.

There have also been instrumentation changes labeled as minimally invasive or anterior specific. These instruments can assist the surgeon with retraction and broaching, but we also prefer standard broach handles as these tend to provide a more reliable feedback than exotic curved type handles, due to their odd center of balance.

The technology of bearing surfaces has also advanced in the recent decades, and although bearing surfaces are not unique to the DAA they are worth mentioning as the DAA patient is typically younger and more active than traditionally treated patients. The gold standard currently in the US is a ceramic femoral head onto highly cross-linked polyethylene (25). There is also the availability of ceramic on ceramic, and although this option may offer the longest potential for minimal wear, we rarely use it due to concerns with potential squeaking.

There is another new product that has recently been introduced and marketed towards the DAA market. It is a surgical impactor that purports to replace the mallet intra operatively. There is currently no peer-reviewed literature available regarding this device and the authors have not yet used it intra-operatively. This device intends to deliver controlled precise impacts to both broaches and inserters to provide a more precise preparation of the femoral canal, and a reproducible impaction force.

Cryotherapy is another area of technology that has some application in rehab after total joint surgery (26). We do not routinely use a motorized cooling unit for our patients involved in our fast track recovery protocol, but the use of low-tech bags of ice can be helpful with initial discomfort after surgery.

Another technological advance that has shown to be an adjunct to rehab and research efforts are patient-based activity monitors. These devices are usually either an application on a smart phone or else a device that communicates with a smart phone to help prompt and/or track the activity of patients, providing real time data back to the operative team (27).

A final area where technology has improved the technique of DAA involves the lighting and retractors. We routinely wear a LED headlight the greatly facilitates the visualization of the surgical field. Without recent advances in battery and LED technology this lighting combination would be too bulky and not offer the amount of light that it does. Adding light to specific retractors has been another way to improve visualization of the DAA, especially with acetabulum preparation. We have found that a helmet mounted light has shown to be the most useful in our practice.

## Conclusions

The previously mentioned advances in technology are all assistive devices that have some place in the world of DAA. The basic principles of surgery and hip arthroplasty are not altered with technology, but hopefully though these innovations the adherence to core quality measures of surgery can be reproducibly obtained by more surgeons.

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