

## **Access Procedures:** *Breaking and Entering Safely and Effectively*

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Some parts of procedural endodontics are consistently fun now, but other parts can still give me the willies after 25 years of chasing the worm. With the advent of landed, variably-tapered shaping instruments and centered condensation filling devices, root canal preparation and obturation procedures have become a predictable, by-the-numbers science as shown by dental student's ideal results in their first attempt at these procedures.<sup>1</sup> However, when cutting access cavities there is always the opportunity of botching the case out of the gate and it is still an art form if you care about creating ideal outcomes. As I tell endodontic graduate students, you want the referring dentist to feel a slight sense of awe when they take out the cotton and Cavit and see how you entered the root canal system.

When the access preparation is cut too small it is often impossible to find all of the canals in the tooth being treated, and even if we find all of the canals, it sets the stage for negotiation difficulties, file breakage and unnecessary frustration during obturation procedures (Fig. 1). Conversely, access cavities that are cut too big are a betrayal of the doctor's first admonishment to do no harm, increasing the short-term possibility of perforation and the long-term probability of tooth and root fracture. Not too small, but certainly not too big—basically we're looking for the "Momma Bear" result here—juuuust right.

Like every other process there are some rules of engagement that will lessen the chances for error, although focused clinical judgment must always be brought to bear in order to solve problems specific to the endodontic case at hand. The following are my best tips, tricks, and get-out-of-jail cards that I think about when I start cutting toward the pulp chamber.

### **Be a student of endodontic anatomy.**

Without a detailed, 3D concept of endodontic anatomy you are heading into enemy territory without a

map. This is critical in general and in specific terms. In general, clinicians must have a three-dimensional, conceptual understanding of how tooth contours play out at the cervical level, where pulp chambers are located in relationship to coronal surfaces, and at what angles canals enter pulp chambers. In specific, clinicians must have well-angulated radiographic imaging of the tooth to be treated.

The best 3D anatomic atlas of endodontic anatomy available at this time is Brown and Herbranson's CD on the subject.<sup>2</sup> It's very cool as it allows the viewer to scroll through 3D reconstructions of teeth in various cut planes, my favorite being the axial planes as they represent what we encounter as we cut down through the lingual or occlusal surfaces of teeth during access procedures. Be curious, look through their data sets of teeth, and do your best to build visual images of these normally hidden spaces in your head.

Entering a tooth without well-angulated x-ray imaging is a fool's errand. My friend Yoshi Tarauchi in Tokyo, Japan acquires a cone-beam CT scan pre-operative to each of his case treatments (boy, do I have equipment envy of him!), but we mere mortals can build a remarkably clear understanding by taking multiple angles of periapical images. While I seldom take inter-treatment x-ray images (my apex locator and paper point blot measurements are far more accurate for length determination) I usually have 3-5 pre-operative images taken and as many post-operative images as needed to show off the treated anatomy, typically 4-6.

With digital image exposures so low we get to gather as many images as we need—my favorite digital image capture devices are Gendex's new HD wired sensors with rounded corners and GE's OpTime phosphor-plates and processor. The images you will get with these devices are crisp, clear, and fast. I've had way too many experiences of being at the bleeding

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edge of new technology so I can understand many clinician's hesitation in this arena, but we're so far beyond that with digital x-ray imaging that it's really no longer even leading edge—you are going to have informed patients judging you poorly if you are not digital. You will get the same dramatic reaction from your patients seeing x-ray images filling a flat screen monitor as you did when you first got an intra-oral camera.

With conventional radiography, we have limited z-plane information (buccal to lingual) and the most control over the x (vertical) and y (horizontal) planes as we cut deep into teeth. One of the most common angulation errors is to shoot x-ray images from too high on maxillary teeth and too low on mandibular teeth, foreshortening the dimensions needed to plan the entry. Horizontal angulation gives us an accurate y-plane reference. Another error is not having an exactly straight-on x-ray of the tooth. Without an ideal buccal view we are giving up control over the x-plane.

Obviously, angled views will help us in our z-plane understanding of the anatomy, but they are limited in range by curving jaw form and adjacent teeth. In general, my best off-angle views are from the mesial on anterior and premolar teeth and from the distal on molar teeth. Without a shallow, distal angle of maxillary molars it is difficult to determine whether an MB2 canal is likely to be found.

In terms of the z-plane view, Yoshi is the king with his CT volume data. In the cases I've done with pre-operative CT scans it was awesome to look at the teeth to be treated from the straight mesial view and to serially scan down through the tooth in axial cross-sections. In the upper molars the axial view revealed MB2 orifices, I was able to snap a line from them to the MB1 orifices, and simply cut straight to them. It was really fun for even a few cases and you know an ICAT machine is still on my wish list.

### **Accept that all perforations are mental errors**

When that small voice in the back of your head says "I wonder if we should take an x-ray image now?" DO IT! That is the creative, procedurally-oriented part of your brain. That's the part that remembers the last time you goofed an access prep. The other voice I call the "office manager"—that's the one that says "you're late, you have three patients waiting in the reception room, the last perf really wasn't your fault, just cut a couple of millimeters further and then I'll let you take an x-ray. Do not listen to that siren's song or you'll experience the dumb chills when the access path goes awry.

Here's one of my best tips on access. Cut just one millimeter deep, through the enamel or casting, evaluate position and direction, and correct any discrepancies before continuing further toward the pulp chamber. It sounds kind of dumb, but it works great. A truism I learned from my Temple U. mentor Dr. Paul Krasner, was that as long as you are on track during an access procedure, you tend to stay on track, but when you start heading in the wrong direction it becomes increasingly difficult to get back on track—the tendency is to overcorrect.

Checking early allows for an easy recovery and quite often I am able to hit the pulp chamber in my next cut. Most clinicians do their first check of position and direction after they are two to four millimeters in and I'm embarrassed to say that I was a member of that club. I've instituted my one-millimeter rule in the last five years and my error rate has dropped significantly. For general dentists, avoiding perforation is the key concern—for endodontists it's different—everyone is a critic.

If you feel anxious during an access procedure, pay attention. In calcified teeth with elusive pulp chambers (or no pulp chambers) you must be patient and creative. Take the rubber dam off, put wedges interproximally, think real hard before cutting further,

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and stop yourself until you know where you are going. No tooth was ever perforated by a dentist who stopped in time—that's why endo is so hard—we can't blame it on the patient when the bur exits the side of the tooth.

### **Choose safe, effective burs**

Simply choosing the wrong bur can presage a poor access result. Using burs that are too large will inevitably increase size of the final cavity preparation as well as significantly increase the chance of perforating the tooth. With a too-large bur, even slight mis-directions have unnecessary consequences. A #4 round bur is too big to enter anterior and premolar pulp chambers so I use a #2 round for that job, a #6 is too big to enter molars but a #4 is ideal.

A common access recommendation is to use round burs in an upward motion to lift off the roofs of pulp chambers and I did that for many years, but as I have tuned my preps to have better conservation form I've found that this technique leads to significant over-preparation. Instead, as soon as I drop into the chamber the round bur has accomplished its purpose and is replaced with a tapered diamond bur, the instrument with which I cut the majority of my access cavities. Finally, round burs cut very irregular shapes in access walls, a result that makes every following part of the RCT more difficult.

Using flat-ended burs also makes highly irregular access walls—literally creating multiple ledges that will catch instruments and materials on their way into root canal orifices. Round-ended carbide fissure burs cut through cast restorations just as fast as flat-ended versions, round burs provide a very distinct tactile sense when dropping into chambers, and if you must use an end-cutting diamond to finish the preparation, a round-ended diamond is best.

Better yet, use access finishing burs with safe, non-cutting ends. These are less likely to ding or perforate pulp chamber floors and they are guided (depending

on their design) in their travels by the pulp chamber walls. There are several of these safe-ended access burs on the market, most all of them have no diamond grit or cutting flutes on their ends so as to limit apically directed cutting. The deficit of these instruments is that they can still easily cut too far laterally and they cannot drop into small orifices to funnel the point of transition between the access cavity and canals.

A bur that I designed for SybronEndo has a reduced and extended non-cutting pilot tip (Fig.2) that limits its lateral movement as well, so that it functions like the bearing on the end of a router bit—guiding the bur around the periphery of the pulp chamber so that the clinician need only worry about cutting at the right angle. Because its pilot tip diameter is reduced to .2 mm's, the LAX (Line-Angle eXtension) Bur can also drop into canal orifices, allowing it to flare the orifice for a smooth, ledge-free transition from access wall to canal. Furthermore, the bur can be angled into the orifice of a canal that is curving as it enters the pulp chamber (as most molar canals do), and the bur can then be gimbaled up to the ideal line angle extension with very little effort.

I've invented a lot of different endodontic instruments in my day, but I have to say that the LAX access diamond is the single-most useful instrument in my armamentarium. The LAX Bur has reduced my anterior and premolar access times to less than two minutes, and my molar times to less than four minutes in uncalcified cases—while simultaneously improving my line-angle extensions and allowing more conservation of tooth structure. (Check out LAX burs in action in video clips on my website [www.endobuchanan.com](http://www.endobuchanan.com))

### **Add ultrasonics to your access set-up**

Since Gary Carr introduced ultrasonic cutting instruments to endodontics for root-end preparations, every year has seen further application of this technology to RCT. We use ultrasonic devices to vibrate posts

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and broken files out of canals, we use them to find calcified canals, we use them to activate irrigating solutions, and the list continues. Spartan Company has been a part of this revolution from the start and they have relentlessly developed further tip designs, some of them outside of endo, such as the Sheets/Paquette MicroPrep operative tips.

In conventional access applications, ultrasonic devices are extremely helpful as there is no handpiece head to block the clinician's view, they cut in any direction needed, and the control they allow is minute. Any clinician who does molar endo without ultrasonics is working too hard, is experiencing more anxiety than is necessary, and is most likely not finding MB2 canals in more than 40% of their upper molar cases (50-60% is a minimal expectation since they are present 70% of the time). In terms of doing no harm, the improved view and added control significantly reduce the chance of creating a perforation—reason enough for those of us who treat a lot of molars.

Spartan asked me to design a set of conventional access tips, the result seen in Figure 3. They are diamond-coated for effective cutting, they have water ports to keep them cool when necessary, for instance, when vibrating posts out of canals, and they are remarkably resistant to breakage at even the highest power levels on the Spartan Unit. They come in three basic designs, each design in two different sizes.

The BUC-1 is for finding calcified canals and for refining access cavities and, importantly, has a rounded tip. Hunting for calcified canals with a sharp-tipped instrument is frustrating as it makes little ledges around the orifices and faux isthmuses when looking for MB2 canals. The BUC-1A is half the diameter of the BUC-1, and is useful for opening isthmuses and for opening the coronal thirds of canals prior to using rotary files.

The BUC-2 has a flat-ended tip for sanding the pulp chamber floors of molars when attached denticles

have had to be cut off. Smoothing pulp chamber floors eliminates small denticle remnants and evens out the coloration of the floors, allowing easier location of orifices. This tip, with its small stalk and its large head, is very active and therefore excellent for banging out posts (with water spray as coolant). As with each of the tips in this set, there is a BUC-2A that is half the tip diameter for narrower applications, such as tight line-angle corners and premolar floors. The BUC-3 is the only sharp-tipped design in the set and is appropriate for cutting a ditch around posts. The BUC-3A, again being half the diameter of the BUC-3, works well for vibrating out files broken in the coronal half of canals.

All of these tips have diamond grit and water ports. Diamond-coated tips cut far faster than titanium nitride-coated tips, and the water ports are an absolute requirement for heat generating functions such as post removal.

### **Cut access cavities with both convenience and conservation form**

To some, these two objectives may seem mutually exclusive. They aren't, but it does take more thought and effort to accomplish both. Fortunately, using pilot-tipped access burs, ultrasonic tips and magnification makes it possible to preserve tooth structure while creating ideal file paths, and in much less time than it took before. The following are some of the landmarks I consider when designing and cutting access cavities.

In anteriors and premolars the convenience form is afforded by extending the prep from buccal to lingual, while the conservation form is accomplished by preserving tooth structure in the mesial to distal dimension. In anteriors extend the cut to just shy of the incisal edge or cusp tip and into the center of the cingulum area, being careful to also cut out the dentin underneath the cingulum extension (Fig. 4).

For ideal rotary file paths in posterior teeth cut the

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line-angle extensions to, or nearly to, the working cusps and stop 1-2 mm's short of the idling cusps. So in maxillary premolars and molars, the line angle extensions are taken to the palatal cusps (working) and are short of the buccal cusps (idling) (Fig. 5). Conversely, in mandibular premolars and molars the line angle extensions are taken to the buccal and are short of the lingual cusps (Fig. 6). These are very simple and very effective landmarks.

In molars, the most common access errors are caused by cutting too far to the distal and not far enough to the mesial. Files placed in distal canals of lower molars and in DB canals of upper molars will be seen with their handles angled way over the mesial aspect of the tooth, evidence that distal extension of access cavities in these teeth is unnecessary and unconservative (Fig. 7). Furthermore, when distal walls are overcut, a large ledge is created that will cause frustration through the rest of the procedure.

Without tipping the mesial wall of the cavity it will be difficult or impossible to find and treat the mesial canals, especially in second and third molars. However, be aware that these mesial walls cannot be cut perpendicular to the occlusal surfaces of these teeth or, again, a large ledge form will be created and even mesial perforation is possible.

In most molars, upper and lower, the ideal mesial extension landmark is the mesial surface of the tooth—you want to be approximately 2.5 mm from that mesial surface—parallel in both the buccal-lingual plane as well as the corono-apical plane (Fig. 8). Why? Because when the mesial access wall is cut this distance back from the mesial surface of the tooth, it drops exactly into the mesial canals at the line angle between the mesial wall and the pulp chamber floor. Without this degree of mesial wall extension it is virtually impossible to find MB2 canals as they enter the pulp chamber from a mesio-apical direction (Fig. 9).

Accomplishing this objective used to be really difficult—now, with a pilot tip access bur like the LAX Bur, it is very easy. Simply place the narrow radiused pilot tip into each canal orifice and with the bur spinning at high speed, and gimbal the bur up to the desired line angle extension. Pushing the bur one millimeter into each orifice will cut a perfect funnel shape into that most coronal part of the canal, smoothly connecting the access cavity to the canal space with no irregularities to hamper file, gutta percha, or paper point introduction.

### **Do not cut access cavities to the full circumference of pulp chambers**

The traditional advice was to cut access cavities to the full circumference of pulp chambers, but it's been my experience that this results in gross waste of healthy tooth structure with no improvement of convenience form. After loss of coronal seal, vertical root fracture is the leading cause of long term failure of endodontically-treated teeth—an outcome set up by over-preparation of coronal and radicular regions and the attendant loss of structural integrity.

The most obvious example of where this old recommendation is bankrupt is in maxillary incisors. For these teeth we have been taught to cut triangular-shaped access cavities, so that the mesial and distal pulp horns have been unroofed, thereby unnecessarily cutting an access preparation that is up to fifty percent larger than is necessary. Instead, I recommend that a slot-like cavity be cut as described above—providing a straight file path into the canal—after which the round-ended tip of an ultrasonic device (Spartan Buc-1), or tapered diamond bur in a high speed handpiece, or a Meuller bur in a slow speed handpiece be used to bevel the pulp chamber roof coronal to the mesial and distal pulp horns. By minimally unroofing these pulp chamber projections, clinicians can be assured that no pulp debris remains in them and also that a significant undercut has been created which

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will mechanically lock the core build-up into place, insuring the long-term seal (Figs. 10 and 11).

### **A couple of final thoughts on entering without breaking**

Perforations of anterior teeth invariably penetrate the buccal root surface, so when you are five millimeters in, haven't found the chamber, and are wondering whether you should cut more to the buccal or lingual, head toward the lingual. If the incisal edge is intact it is truly difficult to perforate on the lingual surface of these teeth. Likewise, lower premolars have buccal cusp tips that are almost over the center of their roots so they are also easily perforated on the buccal when access has been cut equidistant between the buccal and lingual cusps and the access is directed at a right angle to the tipped occlusal surface of the tooth. If you feel lost when deep in these teeth, again head to the lingual, it's safer.

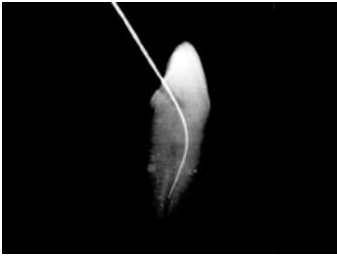
Finally, I just have to say....why would you ever treat a calcified tooth if you didn't have to? Are you mental? The only reason endodontists treat calcified teeth is because they have to—you don't if you are a general dentist! If all you send out are calcified cases you passed the IQ test, but you might occasionally consider treating your endodontist to lunch, that's the hardest part of their job, or better yet send them an easy case so they have a chance to stop hyperventilating.

Figure 9. Close-up of mesial wall of access cavity in maxillary molar at Mesio-buccal line angle. Note the white line extending to the left from the MB1 orifice—the isthmus between the MB1 and MB2 canals. The MB2 is typically found at the palatal extent of that isthmus line.

Figure 10. Maxillary molar with ideal access cavity showing Buc-1 tip being used to bevel the roof off of one of the buccal pulp horns while preserving tooth structure coronal to the pulp horn.

Figure 11. mCT reconstruction of mandibular molar after access preparation that created ideal file paths while preserving tooth structure coronal to the large buccal and lingual pulp horns.

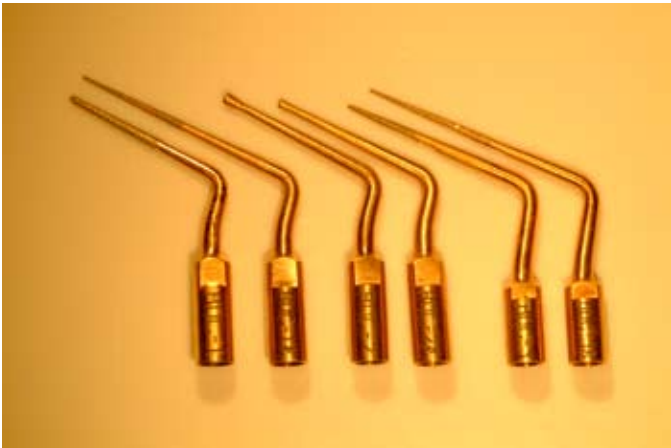
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*Figure 1* Anterior access cavity with inadequate extension causing cervical flexure of file—a set-up for instrument breakage from cyclic fatigue.



*Figure 2* SybronEndo's LA Axxess bur with its extended pilot tip and parabolic flaring shape joining the pilot tip with the standard taper shank portion.



*Figure 3* Buc ultrasonic tips by Spartan Company. Left to right are the Buc-1, Buc-1A, Buc-2, Buc-2A, Buc-3, and the Buc-3A.

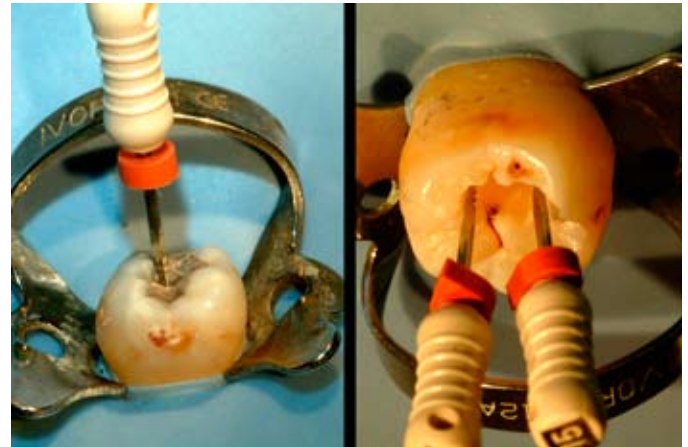


*Figure 4* Anterior tooth with ideal access cavity. Note the extension from just shy of the incisal edge to the middle of the cingulum area and the limited mesial to distal width of 1.5 mm's.

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*Figure 5* Maxillary premolar and molar with line angle extensions cut to lingual cusps (working) and short of buccal cusps (idling).



*Figure 6* Mandibular premolar and molar with line angle extensions cut to buccal cusps, working and idling cusps, respectively.

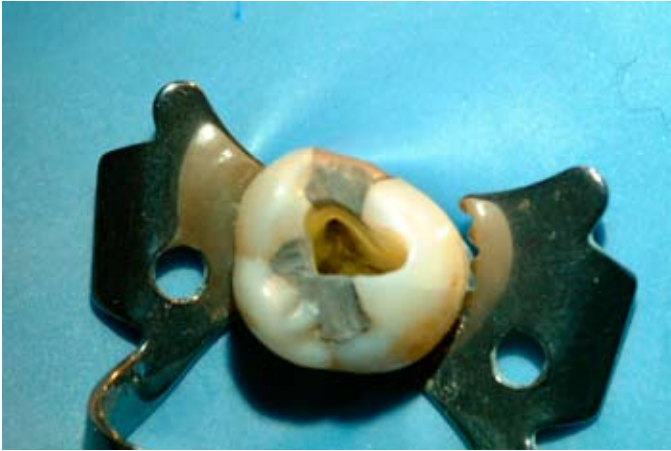


*Figure 7* Files in distal canals of upper and lower molars, showing their natural mesial angulation which belies the need for tipping the distal wall of the access cavity much past the midline.

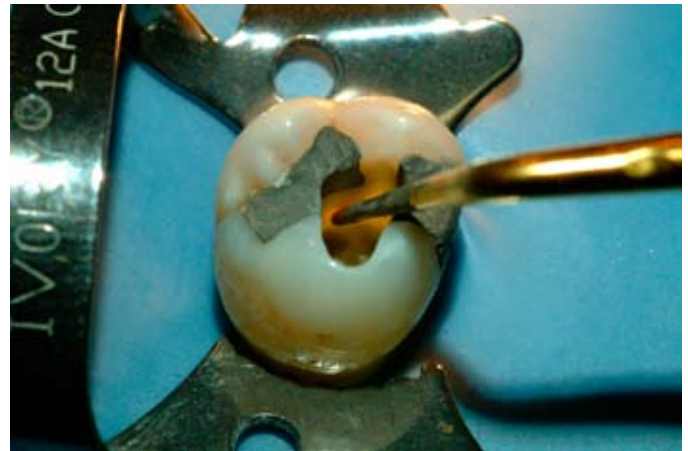


*Figure 8* Sagittal dissection of lower and upper molars showing the mesial tipping of access cavities. Note how the mesial walls are parallel with the mesial surfaces of the teeth.

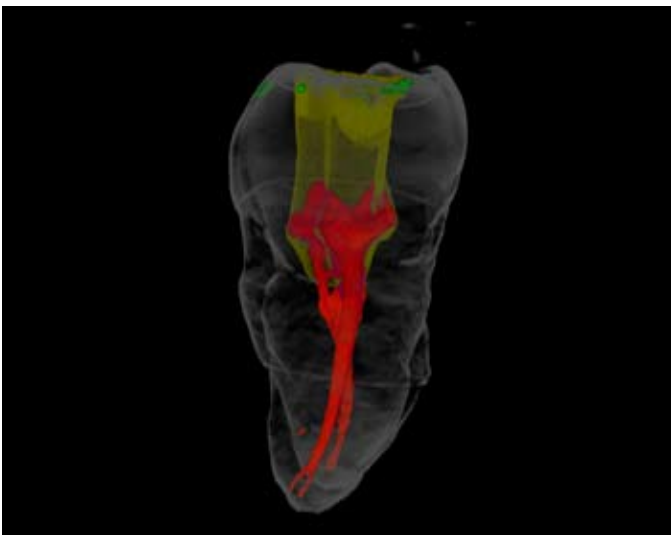
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*Figure 9* Close-up of mesial wall of access cavity in maxillary molar at Mesio-buccal line angle. Note the white line extending to the left from the MB1 orifice—the isthmus between the MB1 and MB2 canals. The MB2 is typically found at the palatal extent of that isthmus line.



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