It is now entirely accepted that early gut-strung instruments were strung near their breaking points – one only has to read various old treatises to see comments such as “tune the top string until it is just about to break”. Such a comment is usually greeted with amusement by all who hear it with comments generally along the lines of “you only know it was about to break when you go too far”. In truth though, it is usually easy to tell if a string is about to break – it does start behaving noticeably different. The questions become – quite how near the breaking point does one go, and what the actual breaking pitch is. One can, of course, get some gut strings by different manufacturers and test them in the hope that strings have not changed that much since the sixteenth century, but such a move is perhaps not as valid as it might appear. In any case, it still doesn’t begin to answer the question about how close to breaking point players routinely went in practice. Instead, it is perhaps wise to try and determine from some historical basis where the levels are likely to be.  
  
This can be quite an issue when it comes to modern players of the two types of historical instruments which used gut strings – lutes and viols. Indeed, modern players of those instruments appear to have devolved greatly (from the start of the early music revival) in their attitude towards historical pitch levels. Players of the viol generally have their instruments with top strings tuned to *d* or *g* (according to its designation) at either modern pitch or a semitone lower (so-called baroque pitch) regardless of the string length. It should be noted that viol players have always (in the revival) used gut strings, albeit with overspun basses). Lutenists will talk of their instruments as “in g” or “in f”, or whatever, always in relation to modern pitch. That is, a lute “in g” has its top string tuned to g' at modern pitch. Many lutenists have played using nylon strings (again with overspun basses), and it is perhaps here that the reasons for the divergence have arisen. It is perfectly possible to have a modern viol player tuning an instrument with a 630 mm string length (a “small bass”) to modern d', whilst a lutenist will tune the same string length at up to modern g' (a “mean lute”). This difference, a fourth, is not to be expected under any interpretation of tuning the string until it is “just about to break”.  
  
Where it might be perfectly possible to tune a modern gut string to g' with a 630 mm string length, the evidence does not appear to support the argument that such a pitch was achieved historically. However, determining what might be reliable pitch levels for gut string lengths is always open to debate – how often can it be said that a particular instrument, in a particular set up, played at a specific pitch level?  
  
Knowing a particular pitch level at a place and time may be of limited use. Laux Maler, working in Bologna in the first-half of the sixteenth century left (listed in an Inventory taken a few days after his death) over 1100 finished instruments, of which 638 were large, 15 middle-sized and 366 small (the others did not have their sizes recorded). That might describe instruments we would consider as bass, mean and treble; but they may well have been closer in size than that, perhaps what we would describe as “in e”, “in f” and “in g”. Surviving instruments clearly show that there were more than the three basic sizes being manufactured. On the other hand, the variety of surviving English viol sizes makes it impossible to make any relationship between size and pitch – the variety of English pitch levels (each separated by semitones) appears to correspond with the difference in sizes, but that cannot be shown to mean that an English viol of a particular size was specifically intended for a corresponding pitch level.  
  
Perhaps the safest way to commence with placing pitch levels and string length together is by looking at recent gut-strung instruments and their pitch levels. The most recent instrument to use gut strings as standard is the modern classical guitar with an established string length of 650 mm, producing e' at modern pitch (prior to the widespread use of nylon in the years following the second War). Prior to that, instruments of the violin family also used gut for the treble strings, although determining their “usual” pitch level is more problematic. By going much further back, to the writings of Michael Praetorius in 1618, we see he writes that:  
  
“This pitch [a semitone above modern pitch, c A460] is often found too high – and not only for singers, but also for string players. Violins, viols, lutes, pandoras, and so on require extraordinary strings to cope with such high tuning. Thus it happens that the top strings break in the middle of performance…”  
  
With a string length of around 330 mm, this would appear to set the upper limit on the tuning/pitch/string length relationship. This can be confirmed, to an extent, returning to the nineteenth century, where it can be seen that English pitch in the 1850s could be as high as A453, a quarter of a semitone below the pitch which Praetorius felt was too high. The majority of Europe (using violins of the same size) would typically play at around modern pitch – perhaps ± 5Hz, that is A435 – A445. Given the huge numbers of instruments involved, then it may be suggested that a violin with a 330 mm string length can be tuned to a pitch of A445 with acceptable comfort (ie. without breaking strings too prematurely). This relationship is nearly a half a semitone closer to absolute breaking pitch than the classical guitar (if converted to modern pitch the string would be 667½ mm).  
  
Such a level seems to be confirmed by baroque guitars, many French and Venetian examples which have string lengths around 685 mm. Assuming the pitch in France to be between A403 and A415, and the low pitch in Venice to be c A410 (which shall be used as an acceptable average for this calculation), it means that, if converted to modern pitch it would be 638 mm (about three-quarters of a semitone less close to breaking than the nineteenth-century violin). Baroque guitars have the advantage of more leeway with treble strings as they do not descend so far into the bass.  
  
There are instruments which must have been closer to the absolute breaking point, such as quintons and pardessus de viols, both with top strings tuned to g' at A392 at the lowest and a 330 mm string length, which is the equivalent of modern f' at A440.  
  
An important issue to remember is that there is no logical reason to assume instruments, even by the same maker, were intended for the same pitch. Thus, an instrument like the guitar by Stradivari in the Ashmolean Museum (740 mm string length) will not necessarily be at the same pitch as the example in the National Music Museum (650 mm string length), despite the maker and players considering both instruments to be tuned “to e”. Likewise, the V&A Museum Tielke (720 mm string length) is not likely to be at the same pitch as the example in the Royal College of Music (630 mm string length), or an example in the Musikhistorisk Museum Copehhagen (C83), originally with a c 667 mm string length. It would be possible that the three instruments are each tuned a semitone apart.  
  
The willingness for makers to build instruments at different pitch levels, and the use of multiple pitches in a particular location, makes it difficult to regard any examples of surviving instruments as providers of evidence without some confirmation of their actual musical use. For example, the Talbot Manuscript (England, c 1690) gives dimensions of a variety of instruments and their tunings. Included in the manuscript is a “French Lute” (by Maler or Sellier), measured at 709 mm string length (tuned to f'), an “English two-headed lute”, measuring 596 mm string length (also tuned to f'), and an archlute, measuring 685 mm string length, tuned to g'. The difference between the two instruments tuned to f' is the equivalent of three semitones. One solution could be that the French lute is tuned to English consort pitch (A400) and the English two-headed lute to English quire pitch (A473), where both would have the stress-equivalent the same as nineteenth-century English violins. It cannot be known if that is the correct interpretation, and even if correct, it cannot help explain the archlute with its g' tuning and 685 mm string length (the same string lengths as many baroque guitars which are tuned to nominal e'.  
  
Likewise, Talbot’s various viol dimensions present difficulties of interpretation, although it can be shown that even the largest, the bass viol measuring 812 mm (much larger than any surviving English bass viol) could still play at consort pitch relatively comfortable, having a stress equivalent similar to a violin tuned to modern pitch (A440). The smaller English viols, those with string lengths around 680 mm, may well represent a group at a higher pitch, the two types matching the pitch levels suggested above for the lutes.  
  
So how does this relate to modern players of gut strung instruments? Viol players will play all their instruments at either A440 or A415, usually depending on the preference of the particular consort, and there are probably comparatively few consorts with matched instruments. In practice the bass instruments are well below breaking, as the models chosen tend to be smaller ones, whereas treble viols may be close to the limits described above – a treble viol tuned to A440 should have a string length of 370 mm and one at A415 of 392 mm to have the equivalent stress as a violin at modern pitch.  
  
Lutes, on the other hand, tend to exceed these lengths. Using the same stress equivalent as the violin at modern pitch, a lute “in g” should have a string length of 555 mm, and one “in f” should be 622 mm. Lutes of around 670 to 680 mm can reach a pitch of e, but at stresses close to that found in nineteenth century violin pitch levels. Many makers offer instruments with string lengths of 610 or 620 mm as “g lutes”. Whereas it is accepted that modern gut can reach that high (since, obviously, it would break if it couldn’t), there isn’t the historical evidence to suggest such pitch levels were obtained in the sixteenth or seventeenth centuries.