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Historical Perspective

A mini review of scientific and pharmacopeial requirements for the disintegration test

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Abstract

Disintegration is a performance test for oral dosage forms that is described in the United States Pharmacopeia (USP), the European Pharmacopeia (EP) and the Japanese Pharmacopeia (JP, chapter 14, 2001).

This review lists changes that have been made since the USP 23 and compares them to those in the USP 30, EP 5.3 and JP XIV. The differences between the disintegration test methods in the three pharmacopeias are discussed. Examples are provided where disintegration can be used as a performance test for ensuring the drug release.

Keywords: Disintegration; USP; Pharmacopeia; Performance test; Solid oral dosage forms; Liquid filled capsules; ICH

Contents

1. Disintegration test procedures in the USP

The United States Pharmacopeia (USP) has two general chapters which describe the disintegration tests, chapter ⟨7 0 1⟩ and ⟨2 0 4 0⟩ under dietary supplements. Chapter ⟨7 0 1⟩ in the USP describes apparatus A which contains a basket-rack assembly with six observation cylinders (USP 30, chapter ⟨7 0 1⟩, 2007a) while apparatus B is described in chapter ⟨2 0 4 0⟩ which contains three observation cylinders with a larger diameter (USP 30, chapter ⟨2 0 4 0⟩, 2007b). Apparatus B is used when the dosage form exceeds 18 mm in length (USP 30, chapter ⟨2 0 4 0⟩, 2007b).

The Japanese Pharmacopeia No. 14 (JP, chapter 14, 2001) does not list such a "Bolus basket assembly" however, this basket assembly is described in the European Pharmacopeia No. 5.3 (EP, method 2.9.1, 2006).

According to the USP the disintegration test is provided to determine whether tablets or capsules disintegrate within the specified time when placed in an immersion medium under defined experimental conditions. Complete disintegration does not mean complete dissolution but "the state in which any residue of the unit, except fragments of insoluble coating or capsule shell, remaining on the screen of the test apparatus or adhering to the lower surface of the disk, if used, is a soft mass having no palpably firm core" (USP 30, chapters ⟨7 0 1⟩ and ⟨2 0 4 0⟩, 2007a,b).

For the test in chapter ⟨7 0 1⟩ the dosage form units are placed in a basket-rack assembly, which is moved vertically along its

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Table 1
Beaker specifications and distance of the bottom wire mesh of apparatus A in the USP, European Pharmacopeia and Japanese Pharmacopeia

Apparatus A	USP 23 ⟨7 0 1⟩	USP 26 ⟨7 0 1/2 0 4 0⟩	USP 30 ⟨7 0 1/2 0 4 0⟩	European Pharmacopeia (5.3, 2006)	Japanese Pharmacopeia (14, 2001)
Volume of beaker (mL)	1000	1000	1000	1000	–
Height of beaker (mm)	142–148 (USP 23, suppl.9)	138–155	138–160	149 ± 11	About 155
Diameter (inside, mm)	103–108 (outside) (USP 23, suppl.9)	97–110	97–115	106 ± 9	About 110
Upward stroke: distance wire mesh/surface (mm)	≥25	≥25/25	≥15/25	≥15	–
Downward stroke: distance wire mesh/bottom (mm)	≥25	≥25/25	≥25/25	≥25	25

axis in a specified immersion medium at a temperature between 35 and 39 °C at a constant frequency rate between 29 and 32 cycles/min. The time required for the upward stroke is equal to the time required for the downward stroke through a distance of not less than 53 mm and not more than 57 mm. These specifications are similar in EP and JP and for apparatus A and B in the USP. However, the different pharmacopeias have slightly different specifications for the beakers, basket assemblies, disks and list different conditions to test dosage forms.

Table 1 lists the beaker specifications of the USP 23, 26, 30, EP and JP. As shown the beaker specifications went from a very narrow range in USP 23 to a rather wide range in USP 30. USP and EP require a 1000 mL beaker while JP does not mention this. However, USP, EP and JP outline the beaker dimensions. The height of the beaker has been changed twice since USP 23 and now USP 30 lists the same range as the EP does. No data are available which show that these changes in the beaker specifications have had any or no impact on disintegration time.

USP 30 chapter ⟨7 0 1⟩ states "At no time should the top of the basket-rack assembly become submerged". To accommodate this requirement USP 30 changed the specifications of the distance of the bottom wire mesh in chapter ⟨7 0 1⟩ to: "the wire mesh should remain at least 15 mm below the surface of the fluid at the highest point of the upward stroke and at least 25 mm from the bottom of the vessel on the downward stroke". This is the same requirement as in EP, but the JP does not specify the upper distance.

The requirement of the basket assembly not to be submerged makes it necessary to determine the exact volume of the immersion medium needed for each beaker used if they have different inner diameters. Also this specification makes the height specification of the beaker mentioned earlier not necessary. However, standard operating procedures developed prior to this specification might have used a fixed volume of immersion medium for the test.

The diameter of the beakers changed from USP 23, supplement 9 (103–108 mm, outer diameter) to USP 30 (97–115 mm, inner diameter). These changes have been made based on the attempt to accommodate "International Manufacturing Standards" (USP, personal communication) and to harmonize with EP and JP (USP 30, chapter ⟨7 0 1⟩, 2007a). However, no data exist to show that this does not impact the disintegration time.

The moving range of the basket-rack assembly should be between 53 and 57 mm and as outlined above, the height of the basket from the bottom should be at least 25 mm and 15 mm from the top. This is a total height of 93–97 mm. Taking the current beaker diameter specifications into account this adds up to a volume of between 687 and 1007 mL depending on the beaker

Table 2
Basket-rack assembly and disk specifications in USP, EP and JP

Apparatus A: basket-rack assembly	USP 23 ⟨7 0 1⟩	USP 26 ⟨7 0 1⟩/⟨2 0 4 0⟩	USP 30 ⟨7 0 1⟩/⟨2 0 4 0⟩	European Pharmacopeia	Japanese Pharmacopeia
Number of tubes	6	6	6	6	6
Length (mm)	77.5 ± 2.5	77.5 ± 2.5	77.5 ± 2.5	77.5 ± 2.5	77.5 ± 2.5
Inside diameter (mm)	About 21.5	20.7–23	20.7–23	20.7–23	21.5 ± 0.5
Wall thickness (mm)	About 2	1.0–2.8	1.0–2.8	1.0–2.8	1.5–2.5
Diameter of plates (mm)	About 90	88–92	88–92	88–92	About 90
Thickness of plates (mm)	6	5–7	5–8.5	5–8.5	6
Number of holes	6	6	6	6	6
Diameter of holes (mm)	About 24	22–26	22–26	22–26	24
Wire diameter (mm)	0.025 in. (0.63 mm)	0.63 ± 0.03	0.57–0.66	0.57–0.66	0.6
Thickness of disk (mm)	9.5 ± 0.15	9.5 ± 0.15	9.5 ± 0.15	9.5 ± 0.15	9.5 ± 0.15
Diameter (mm)	20.7 ± 0.15	20.7 ± 0.15	20.7 ± 0.15	20.7 ± 0.15	20.7 ± 0.15
Gravity	1.18–1.20	1.18–1.20	1.18–1.20	1.18–1.20	1.18–1.20
Number of holes	5	5	5	5	5
Diameter of holes	2	2	2 ± 0.1	2 ± 0.1	2
Number of notches	4	4	4	4	4
Size of notch on the bottom	1.6 × 1.6	1.6 × 1.8	1.6 ± 0.1 × 1.6 ± 0.1	1.6 ± 0.1 × 1.6 ± 0.1	1.6 × 1.6
Size of notch on the top	9.5 × 2.55	9.4 ± 0.2 × 2.6 ± 0.1	9.4 ± 0.2 ×2.6 ± 0.1	9.4 ± 0.2 × 2.6 ± 0.1	9.5 × 2.55

diameter. Since there was previously no volume specified in the USP most analysts added 900 or 1000 mL to the beaker to ensure consistency from test to test. For 900 mL the medium height in a beaker with 115 mm diameter will only be 87 mm. This might not meet the current USP requirements. On the other hand, 900 mL will be too much in a 97 mm diameter beaker if the basket assembly should not be submerged. The new specification makes the wire cloth on the top of the assembly no longer necessary since the assembly is not supposed to submerge completely.

Table 2 lists the requirements for the basket-rack assembly of USP apparatus A.

The open-ended transparent tubes are held in vertical position by two plates and a woven stainless steel wire cloth is attached to bottom surface of the plate.

As Table 2 shows, the USP requirements for the basket-rack assembly have been adapted to the EP specifications.

Some changes have been made from USP 23 to USP 30 in regard to the thickness of the plates, the wire diameter and the size of the notch on the bottom of the disk. The JP specifies a different inside diameter of the tubes and a different wall thickness. These narrower specifications are within the USP and EP ranges.

JP and USP 23 do not describe an apparatus for larger dosage forms as mentioned in the EP. However this apparatus was added for the first time in USP 26 chapter ⟨2 0 4 0⟩. The differences between USP 30 apparatus B and the EP are listed in Table 3. Additionally to the listed differences, EP and USP have different requirements for the distance of the basket assembly from the surface of the immersion medium (USP 30: 25 mm and EP: 15 mm). The specifications for the disks are similar in USP and EP. In USP 30 automatic detection using modified disks is mentioned for the first time. These disks are required to comply with density and dimension given in chapter ⟨7 0 1⟩.

However, the disks specification for apparatus A has changed from USP 27 to USP 30. Now the specification states: "The parallel side of the trapezoid on the bottom of the cylinder has a length of 1.6 ± 0.1 mm, and its bottom edges lie at a depth of 1.6 ± 0.1 mm from the cylinder's circumference". This is similar to the EP specification.

Table 3
Comparison of the specifications of the Bolus assembly

Apparatus B: basket-rack assembly	USP 30 ⟨2 0 4 0⟩	European Pharmacopeia
Number of tubes	3	3
Length (mm)	79.5 ± 0.5	77.5 ± 2.5
Inside diameter (mm)	About 33.3	33 ± 0.5
Wall thickness (mm)	About 2.4	2.5 ± 0.5
Diameter of plates (mm)	About 97	97
Thickness (mm)	About 9.5	9
Number of holes	3	3
Diameter of holes (mm)	About 39	–
Wire diameter	0.025 in.	0.63 ± 0.03 mm
Thickness of disk (mm)	15.3 ± 0.15	15.3 ± 0.15
Diameter (mm)	31.4 ± 0.13	31.4 ± 0.13
Gravity	1.18–1.20	1.18–1.20
Number of holes	7	7
Diameter (mm)	3.2	3.15 ± 0.1

Table 4 lists the different dosage forms mentioned in USP 30, chapter ⟨7 0 1⟩ and ⟨2 0 4 0⟩, and the Japanese Pharmacopoeia. EP does not give general guidelines how to perform a disintegration test for different dosage forms. USP and JP describe the experimental conditions such as the immersion fluid, the time required for the disintegration test and when the disks should be used. The use of disks is relevant since it seems to have an impact on disintegration time due to the impulsive forces acting on the dosage form (Kamba et al., 2003). However, there are differences between chapter ⟨7 0 1⟩ and ⟨2 0 4 0⟩ in USP 30 and the JP.

USP 30, chapter ⟨2 0 4 0⟩ differentiates between vitamin–mineral dosage forms and botanical dosage forms. The JP describes some dosage forms that are not mentioned in the USP, for example pills and granules. Furthermore it contains "tablets coated with suitable coating agents" while USP describes plain-coated tablets and film-coated tablets in chapter ⟨2 0 4 0⟩. USP 30 ⟨7 0 1⟩ does only list uncoated and plain-coated tablets and does not differentiate between film-coated and plain-coated tablets (USP 30, chapter ⟨7 0 1⟩, 2007a).

USP 30 ⟨2 0 4 0⟩ describes the following treatment for plain-coated tablets and delayed-release tablets with soluble external coating: the tablets are immersed in water at room temperature for 5 min before the apparatus is operated. The same treatment is mentioned in ⟨7 0 1⟩ but only for delayed-release tablets whereas plain-coated tablets are said to be tested as uncoated tablets.

For the disintegration test of hard gelatin capsules USP 30 ⟨7 0 1⟩ requires water as the immersion medium while chapter ⟨2 0 4 0⟩ uses 0.05 M acetate buffer. Furthermore ⟨2 0 4 0⟩ tests soft shell capsules using a rupture test (USP 30, chapter ⟨2 0 4 0⟩, 2007b) while chapter ⟨7 0 1⟩ uses the disintegration test apparatus.

The rupture test for soft gelatin capsules is new in the USP 30 but was used previously in some monographs like Dronabinol capsules to ensure drug release. The test is performed in a dissolution apparatus, operating at 50 rpm with 500 mL water as the immersion medium. The capsule should be allowed to sink to the bottom of the vessel, before rotation is started. The time taken for each capsule shell to rupture is recorded and should be under 15 min. If one or two of the capsules tested rupture in more then 15 min but not more than 30 min, the test is repeated with 12 new capsules. The requirements are met if not more than two of the 18 capsules tested rupture in more than 15 min and less than 30 min.

The USP disintegration test is performed over a defined period of time and a product passes or fails at the end of the test. The requirements of the test are met, according to EP and USP if all dosage form units disintegrate or if one or two units fail, the test has to be repeated with 12 additional dosage units. The test is passed, if not less than 16 of the 18 tested units have disintegrated (USP 30, chapters ⟨7 0 1⟩ and ⟨2 0 4 0⟩, 2007a,b, Procedure). The requirements of the JP are different: if one of the tested dosage forms (other than granules) fails to disintegrate, the test has to be repeated with six additional dosage forms. The requirements are met if all six test units have disintegrated (JP No. 14, chapter 14, 2001, Procedure).

Table 4
Disintegration test for different dosage forms in USP 30 ⟨7 0 1⟩, ⟨2 0 4 0⟩ and JP

Dosage form	Experimental conditions	USP 30			Japanese Pharmacopeia
		Chapter 7 0 1	Chapter 2 0 4 0 Vitamin–mineral dosage forms	Botanical dosage forms	
Uncoated tablets (USP) Tablets (JP)	Medium	Water or MS	Water	Water	Water
	Time	TS	30 min	20 min	30 min
	Disks	MON	yes	MON	Yes
Film-coated	Medium		Water	Water	
	Time		30 min	20 min	
	Disks		yes	MON	
Plain-coated (other than film-coated)	Medium	Water or MS	Water	Water	
	Time	TS	45 min	20 min	
	Disks	MON	yes	MON	
Sublingual	Medium	Water or MS			
	Time	TS			
	Disks	MON			
Buccal	Medium	Water or MS			
	Time	1 h			
	Disks	MON			
Delayed-release (USP) Enteric-coated preparations (JP)	Medium	SGF/SIF		SGF/SIF	1st fluid/2nd fluid
	Time	1 h/TS		1h/TS	120/60 min
	Disks	MON		–	-/yes
Hard shell capsules (USP) Capsules (JP)	Medium	Water or MS + WC	0.05 M acetate buffer	0,05 M acetate buffer	Water
	Time	TS	45 min	20 min	20 min
	Disks	MON	–	–	Yes
Soft shell capsules	Medium	Water or MS + WC	Rupture test	Rupture test	
	Time	TS			
	Disks	MON			
Tablets coated with suitable coating agents	Medium				Water
	Time				60 min
	Disks				Yes
Pills	Medium				First fluid (pH 1.2)
	Time				60 min
	Disks				Yes
Granules	Medium				Water or MS
	Time				30 min
	Disks				–
Granules and capsules enclosing drugs in granular form	Medium				1st fluid/2nd fluid
	Time				60 min/30 min
	Disks				–

MS = specified medium, TS = time specified, WC = wire cloth, MON = as specified in the monograph, SGF = simulated gastric fluid, pH 1.2, SIF = simulated intestinal fluid, pH 6.8, 1st fluid = sodium chloride in hydrochloric acid, pH about 1.2, 2nd fluid = potassium dihydrogenphosphate buffer pH about 6.8.

The USP requires that enteric-coated tablets are first treated with simulated gastric fluid and no unit should have disintegrated. The test units are then treated with simulated intestinal fluid. All units should disintegrate but if one or two units fail then the test is repeated as explained above.

The JP uses also two media called 1st fluid and 2nd fluid. They are sodium chloride in hydrochloric acid, pH 1.2, and potassium phosphate buffer, pH 6.8, and are similar to the USP media SGF and SIF. Enteric-coated preparations other than granules and capsules enclosing drugs in granular form are observed after the treatment with the first fluid. If two of six samples are disintegrated the test is repeated as mentioned above. After the treatment with the 2nd fluid all units should disintegrate.

Granules, which are only mentioned in the JP, are treated differently: they are shaken on a No. 30 (500 μm) sieve and then 0.10 g of the residue on the sieve are transferred to each of the six tubes. Water is used as immersion fluid, unless otherwise specified in the monograph, and the granules are observed

after 30 min or 60 min (for coated granules). All granules must disintegrate to comply with the requirements.

Granules and capsules enclosing drugs in granular form, which are also unique in the JP, are sieved as described above and the test is carried out with the 1st fluid. The samples pass the test if particles fallen from the openings of the wire gauze number not more than 15. The same amount of sieved granules is tested in the 2nd fluid for 30 min. The requirements are met if not more than one sample remains intact.

2. Discussion

The disintegration test is a useful performance test of different immediate release dosage forms. Following the instructions made by the USP should result in reliable and comparable results. However it is not known if the differences and changes made over time between the USP, the JP and the EP or even within the USP itself have any impact on the disintegration time. Such aspects have to be taken into consideration to ensure compliance of a product with pharmacopeial requirements within its lifecycle.

2.1. Disintegration as critical quality control test

Disintegration does not measure drug release but it is a prerequisite for drug dissolution. The Biopharmaceutical Drug Classification System (BCS) classifies drugs according to their solubility and permeability properties. For drugs in classes I and III, dissolution might not be rate limiting if the dosage form disintegrates. The highest single dose of BCS I/III drugs will dissolve in the entire physiological pH range of the gastrointestinal tract, i.e. dissolution will take place after the drug has been released by the dosage form which can be determined by disintegration. Different studies have been published indicating that disintegration rather than dissolution might be the more meaningful performance test for certain liquid filled capsules (Han et al., 2006). Consequently, the time point of shell rupture of a liquid filled capsule can be seen as the critical parameter for drug release as long as the drug stays dissolved after shell rupture.

According to ICH Q6A Decision Tree #7 (ICH, 2007) disintegration in place of dissolution testing is allowed for immediate release dosage forms under the following conditions:

1. the drug is highly soluble (dose/solubility volume <250 mL) from pH 1.2 to 6.8
2. the drug releases rapidly (>80% in 15 min) at pH 1.2, 4.0 and 6.8
3. a relationship is established between dissolution and disintegration testing

Using the disintegration test rather then a dissolution test might be desirable, because dissolution protocols require marker substances which must be quantified using analytical methods. This is more time consuming than performing a disintegration test. However, if disintegration is used as a performance test in quality control then it must be reproducible within the set specifications. Fig. 1 gives a decision tree when disintegration can be seen as the critical drug release parameter for a oral dosage form.

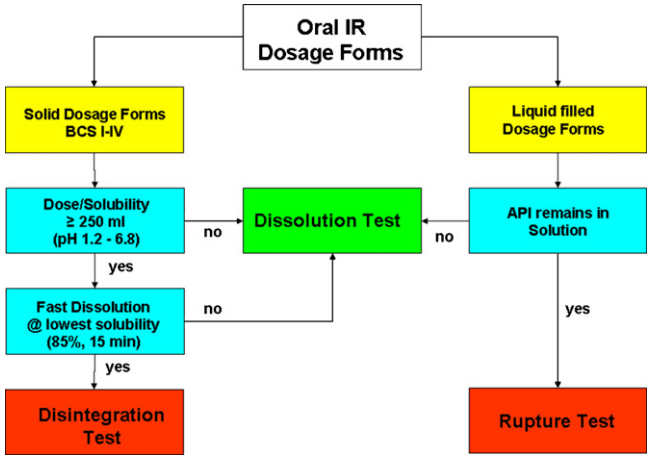

Fig. 1. Decision tree when disintegration might be used as performance test. API: active pharmaceutical ingredient; BCS: Biopharmaceutics Drug Classification System.

2.2. Dosage form influence

As stated before in some cases defined by the ICH Q6A Decision Tree #7 the time point of shell rupture can be seen as the critical parameter for drug release of the capsules (Han et al., 2006). Therefore it is important to know which factors influence shell rupture or shell dissolution. Different kind of capsule materials might react differently to the test conditions or the immersion medium used.

As capsules the USP only mentions gelatin capsules, though hypromellose capsules (hypromellose = HPMC = hydroxypropyl methylcellulose) have become popular for different reasons (Tuleu et al., 2007). Since they do not behave the same way as gelatin capsules in different media the USP should specify how to carry out the disintegration test with HPMC capsules. Such a specification becomes even more necessary as HPMC capsules can be produced with two different gelling agents (Cole et al., 2004), carrageenan ($HPMC_{carr}$) and gellan gum ($HPMC_{gell}$), which again show different properties depending on the immersion media.

Cole et al. tested the *in vitro* dissolution of both gelatin and $HPMC_{gell}$-capsules containing ibuprofen (Cole et al., 2004) (used media: potassium phosphate USP and Tris buffer, pH 7.2) and acetaminophen (used media: water, 37 °C, 0.1N HCl, pH 1.2, sodium acetate buffer USP, pH 4.5, potassium phosphate USP, Tris buffer and sodium phosphate buffer, pH 7.2). The gelatin capsules showed rapid and complete drug release in all media.

The drug release of $HPMC_{gell}$-capsules containing ibuprofen was variable and incomplete after 60 min with a lag time of 15 min in potassium phosphate buffer. The release was much quicker and almost complete after 30 min in Tris buffer.

$HPMC_{gell}$-capsules containing acetaminophen showed dissolution times comparable to that of gelatin capsules in water

and Tris buffer. In acid conditions however the capsule remained practically intact with very little drug release. The release was delayed and variable in potassium phosphate buffer but improved in media containing sodium at pH 4.5 and 7.2 compared to the release in potassium phosphate buffer.

Since the drugs contained in the capsules, ibuprofen and acetaminophen, are soluble in all media used, the observations listed above must relate to the different behavior of the capsule material in the different media.

Acid conditions and the presence of potassium cations hindered $HPMC_{gell}$-capsule disintegration while the *in vitro* release time of gelatin capsules was independent of the composition of the medium in this study (Cole et al., 2004).

Cole et al. also examined the *in vivo* disintegration of $HPMC_{gell}$-capsules compared to gelatin capsules in the fasted and fed state using gamma scintigraphy. Gelatin capsules showed a mean initial disintegration time of 8 min in the fasted and 23 min in the fed state. $HPMC_{gell}$-capsules however disintegrated after 28 min in the fasted and 60 min in the fed state. The lower shell solubility *in vitro* is reflected in the slower *in vivo* disintegration time which can be related to the acid conditions of the stomach and the cations present in the meal.

HPMC-capsules made with carrageenan showed rapid film disruption in water (Nagata et al., 2001) as well as in acid conditions (Sanderson et al., 1984). They also have the same reduced shell dissolution when potassium and sodium cations are present. Tochio et al. stated that the dissolution of paracetamol from $HPMC_{carr}$-capsules was influenced by the concentration of potassium ions (Tochio et al., 2002), as present in USP pH 6.8 buffer and USP simulated intestinal fluid.

Tuleu et al. tested the *in vivo* disintegration time of $HPMC_{carr}$-capsules compared to that of gelatin capsules in fasted conditions when swallowed with water. The mean disintegration time for $HPMC_{carr}$-capsules was 9 ± 2 min and that for gelatin capsules was 7 ± 4 min. The results were not statistically different. As both capsules showed rapid and comparable disintegration times, the study concluded that they can be used interchangeably in the fasted state.

For both $HPMC_{carr}$ and $HPMC_{gell}$-capsules no significant difference in the important pharmacokinetic metrics of C_{max} and AUC was found. Here *in vitro* differences seem to have reduced in vivo relevance (Honkanen et al., 2001, 2002; Cole et al., 2004).

However the *in vitro* differences of gelatin and HPMC capsules will have an impact on disintegration testing when used for quality control purposes. Since the different shell materials seem to show similar *in vitro* disintegration times only in water this medium is recommended to be used for disintegration testing for capsules.

2.3. Chewable tablets

According to the USP 30 the disintegration test does not apply for dosage forms that are to be chewed (USP 30, chapters ⟨7 0 1⟩ and ⟨2 0 4 0⟩, 2007a,b). Wardrop et al. tested the dissolution of different formulations of chewable tablets both crushed und uncrushed prior to the test. They stated that crushing the tablets greatly increased the dissolution rate, as expected (Wardrop et al., 1997). Therefore the disintegration test might be used for quality control purposes of chewable tablets too.

Table 5
Comparison of current and proposed (italic) disintegration methods for dosage forms for USP chapter ⟨7 0 1⟩ and ⟨2 0 4 0⟩

⟨7 0 1⟩ Apparatus A, *Apparatus B*	⟨2 0 4 0⟩ Apparatus A, Apparatus B	*⟨7 0 1⟩*, ⟨2 0 4 0⟩ Rupture test
Uncoated tablets	Uncoated tablets	Soft shell capsules
Plain-coated tablets	Plain-coated tablets	
Film-coated tablets	Film-coated tablets	
Sublingual tablets	*Sublingual tablets*	
Buccal tablets	*Buccal tablets*	
Delayed-release tablets	Delayed-release tablets	
Hard gelatin capsules	Hard gelatin capsules	
Hypromellose capsules	*Hypromellose capsules*	
Chewable tablets	*Chewable tablets*	

Furthermore disintegration tests for chewable tablets are important because the dosage form must disintegrate prior to drug release and not every patient will chew the tablet to the same degree, which will impact the drug's bioavailability.

Disintegration testing is becoming more important as a performance test for quality control purposes of different dosage forms. In the future test conditions for HPMC-capsules and chewable tablets should be added to the list of dosage forms to be tested as shown in Table 5. However more work is necessary to investigate if the current specifications of the disintegration apparatus are sufficient to obtain reliable results over the lifecycle of a product.

3. Conclusion

The disintegration test is not only a useful test for quality control purposes but that in certain instances it can be a critical parameter for drug release. A number of changes made to the disintegration test since the USP 23 need to be evaluated as to whether they will have any impact on the measured disintegration time of dosage forms.

Furthermore, there are dosage forms, such as hypromellose capsules and chewable tablets, that are not described in USP 30 chapter ⟨7 0 1⟩ and ⟨2 0 4 0⟩, for which disintegration test procedures need to be established through further experimentation.

Disintegration will continue to be a valuable quality control procedure, but clearly further work is required to strengthen its place among the tools that assess the performance of dosage forms.

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